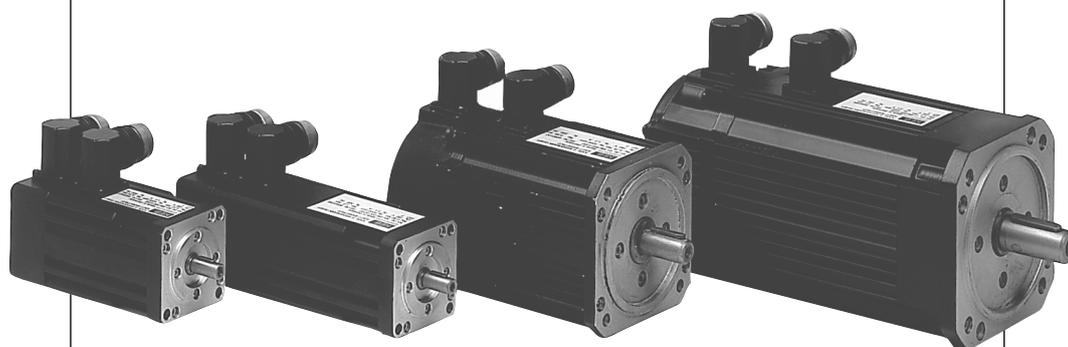


INSTRUCTION MANUAL



Dynamic Line I

GB Servo motors

Size A1...E3

Mat.No.	Rev.
00SM0EB-K014	2B

KEB

This instruction manual describes the motors of the series Dynamic Line II. The safety and warning notes listed in this instruction manual as well as in other documentation must be observed at any rate to ensure a safe operation. Non-observance of the safety instructions leads to the loss of any liability claims. The safety and warning instructions specified in this manual do not lay claim on completeness. KEB reserves the right to change/adapt specifications and technical data without prior notice. The pictograms used here have the following meaning:



Danger
Warning
Caution

Is used when the life or health of the user is in danger or considerable damage to property can occur.



Attention
observe at all costs

Is used when a measure is necessary for safe and disturbance free operation.



Information
Aid
Tip

Is used, if a measure simplifies the handling or operation of the unit.

The use of our units in the target products is outside of our control and therefore lies exclusively in the area of responsibility of the machine manufacturer.

The information contained in the technical documentation, as well as any user-specific advice in spoken and written and through tests, are made to best of our knowledge and information about the application. However, they are considered for information only without responsibility. This also applies to any violation of industrial property rights of a third-party.

A selection of our units in view of their suitability for the intended use must be done generally by the user.

Tests can only be done by the machine manufacturer in combination with the application. They must be repeated completely, even if only parts of hardware, software or the unit adjustment are modified.

Repairs may be carried out only by the manufacturer or repair places authorized by him. Unauthorised opening and tampering may lead to bodily injury and property damage and may entail the loss of warranty rights. Original spare parts and authorized accessories by the manufacturer serve as security. The use of other parts excludes liability for the consequences arising out of.

The suspension of liability is also valid especially for operation interruption damages, loss of profit, data loss or other damages. This also applies if we have been pre-referred to the possibility of such damages.

If individual regulations should be futile, not effective or impracticable, then the effectivity of all other regulations or agreements is not affected by this.

1. General	4	6. Maintenance and repair	25
1.1 Intended use	4	6.1 Maintenance intervals	25
1.2 Safety instructions.....	4	7. Technical Data	26
1.3 Transport and packaging	5	7.1 Self-cooling	26
1.4 Storage.....	5	7.2 Separate cooling	35
1.5 Standards, codes and regulations.....	5	7.3 Torque-speed-characteristic	38
1.6 EC Manufacturer’s Declaration.....	6	7.3.1 Motors of the 230 V class.....	38
2. Product Description	7	7.3.2 Motors of the 400 V class.....	39
2.1 Part code.....	7	7.4 Options.....	40
2.2 Overview of the motor	8	7.4.1 Holding brake	40
2.3 Standard design of the servo motors	9	8. Appendix	41
2.4 Speed-torque characteristic	9	8.1 Certification	41
2.5 Project design	10	8.1.2 CE Marking	41
2.5.1 Selection of the servo motor	10	8.1.3 UL Marking.....	41
2.5.2 Selection the servo controller	10		
2.5.3 Output component	10		
2.5.4 Pretension factor.....	10		
2.6 Construction and definition.....	11		
2.6.1 Drive end and direction of rotation	11		
2.6.2 Shaft end and feather key	11		
2.6.3 Winding and insulation system.....	12		
2.6.4 Holding brake (optional).....	12		
2.6.5 Separately driven fan	13		
2.6.6 Temperature monitoring.....	13		
2.6.7 Speed and shaft position measuring system / resolver.....	15		
3. Operating Conditions	16		
3.1 Degree of protection.....	16		
3.2 Cooling, altitude, ambient conditions	16		
3.3 Permissible axial and radial forces.....	17		
3.3.1 Table	17		
3.3.2 Shaft strain.....	18		
3.3.3 Output component.....	18		
3.3.4 Preloading factor	18		
3.3.5 Horizontal standard.....	19		
3.3.6 Vertical standard	19		
4. Connection	20		
4.1 Conductor cross-section	20		
4.2 Power unit	20		
4.3 Encoder connection	21		
4.3.1 Resolver	21		
4.3.2 Hiperface.....	21		
4.3.3 EnDat	22		
4.3.4 SIN/COS	22		
4.4 Separate ventilator connection.....	23		
5. Start-up	24		
5.1 Preparations.....	24		
5.2 Initial start-up.....	24		
5.3 Operation	24		

1. General

1.1 Intended use

The synchronous servo motors KEB COMBIVERT SM serve for the operation on digital servo controllers and are intended for industrial systems. They comply to the harmonized standards of the series VDE 0530/EN 60034. The use in hazardous areas is prohibited, unless it is explicitly permitted (observe additional instructions).

	<p>Operation within the limit values</p>	<p>The local conditions on site shall comply with the name plate data. If the servo motors are used in machines, which work under exceptional conditions or if essential functions, life-supporting measures or an extraordinary safety step must be fulfilled, the necessary reliability and security must be ensured by the machine builder. The operation of the servo motors outside the indicated limit values of the technical data leads to the loss of any liability claims.</p>
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1.2 Safety instructions

	<p>Electrical qualified personnel</p>	<p>Only qualified personnel are allowed to perform any planning, installation or maintenance work (observe VDE 0105, IEC 364). The personnel must be trained for the job and must be familiar with the installation, assembly, start-up and operation of the product. The instructions given in the manual or any other documentation must always be observed. Improper operation can cause damages to personnel and equipment.</p>
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	<p>Dangerous voltage</p>	<p>During the operation (even at zero speed) the motors posses dangerous live parts. In the case of synchronous motors with rotating rotor a high voltage is applied onto the motor connections. Remove power to the machine before starting any work on the motors. The isolation from supply must be checked and secured.</p>
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	<p>No mains operation</p>	<p>The motors are not designed for direct connection to the three-phase system but are to be operated via an electronic power inverter. Direct connection to the system may destroy the motor.</p>
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	<p>Hot surfaces</p>	<p>The motors can reach a surface temperature of more than 100°C. No temperature-sensitive parts may lay close to or be attached onto the motor. If necessary, protective measurements must be taken against touching.</p>
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	<p>Secure feather key</p>	<p>Before commissioning motors with a shaft key, secure the key to ensure that it cannot be thrown out if this is not already prevented by driving elements such as a belt pulley, coupling, etc.</p>
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	<p>Operation with integrated brake</p>	<p>Check the proper functioning of the brake (optional) after installing the motor. The optional holding brake is only designed for a limited number of emergency brakings. The use as a working brake is not permitted. On motors with plug connector and built-in brake, it is the user's responsibility to install the varistor provided to control the brake.</p>
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	<p>Protection of the motor winding</p>	<p>The temperature sensor fitted in the winding is to be connected and evaluated by a suitable wiring, for the protection of the motor against thermal overload in case of slow changes. Attention: The thermistor does not represent an all-around protection of the winding. The thermistor does not represent an all-around protection of the winding. Therefore, additional measures such as monitoring i^2t- by the inverter electronic system are required to protect the motor from fast arising thermal overload.</p>
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1.3 Transport and packaging

The packaging and transport technologies are dependent on the shipping conditions. The following types of packaging are provided:

- Folding boxes
- Covered and steel-strapped flat pallets (transport by truck)
- Special pallets
- Special packaging in wooden cases

The motors should always be shipped so that no damage can occur in transit.

	Caution during transport	Avoid any impacts, sharp sudden movements and strong vibrations during transport. Operate the crane only at creeping speed to lift or place down the motors. This prevents damage to the bearings or the machine.
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After final tests all motors leave the factory in perfect condition. Make a visual check for any external damage immediately upon their arrival on site. If any damage caused in transit is found, make a notice of claim in the presence of the forwarder. In addition, report the damage to the manufacturer at the latest within one week. Do not put these motors into operation.

1.4 Storage

If the motors are not installed immediately after their arrival, they should be properly stored. Store the motors only in closed, dry, dust-free, well-ventilated and vibration-free rooms. Damp rooms are unsuitable for storage! Do not remove the anti-corrosive coat from the shaft ends, flange surfaces etc. Check it at certain intervals depending on the ambient conditions and touch up, if required

Take care that no vibrations occur in storage to prevent the anti-friction from being damaged. It is advisable to turn the rotor several times at certain intervals to prevent corrosion of the bearings.

After a longer storage (> 3 months) operate the motor at slow speed (< 100 min⁻¹) in both directions, so that the lubrication can spread evenly in the bearings.

1.5 Standards, codes and regulations

Servo motors are designed in accordance with IEC recommendations and the applicable VDE and DIN standards (see table opposite). The motors are manufactured in accordance with the international quality standards ISO 9001.

Title	DIN/VDE	EN	IEC
Rotating electrical machines; rating and performance	DIN VDE 0530 Part 1	EN 60 034-1	IEC 600 34-1
Terminal markings and direction of rotation	DIN VDE 0530 Part 8	EN 60 034-8	IEC 600 34-8
Classification of types of construction and mounting arrangements	DIN VDE 0530 Part 7	EN 60 034-7	IEC 600 34-7
Methods of cooling	DIN VDE 0530 Part 6	EN 60 034-6	IEC 600 34-6
Classification of degree of protection by enclosures	DIN VDE 0530 Part 5	EN 60 034-5	IEC 600 34-5
Mechanical vibration of certain machines - Measurement, evaluation and limits of vibration severity	DIN VDE 0530 Part 14	EN 60 034-14	IEC 600 34-14
Noise limits	DIN VDE 0530 Part 9	EN 60 034-9	IEC 600 34-9

further on next side

General

Cylindrical shaft ends for electrical machinery	DIN 748 Part 3		IEC 600 72
Integrated thermal protection		EN60 034-11	
Tolerances of shaft extension run-out and of mounting flanges for rotating electrical machinery	DIN 42 955		
Mounting flanges for electrical machinery	DIN 42 948		

1.6 EC Manufacturer's Declaration

CE marked motors were developed and manufactured to comply with the regulations of the Low-Voltage Directive 2006/95/EC.

The motors must not be started until it is determined that the installation complies with the machine directive (2006/42/EC) as well as the EC EMC Directive (2004/108/EC). If necessary, a manufacturer's declaration is available at KEB.

2. Product Description

2.1 Part code

A 2 . S M . 0 0 0 - 6 2 0 0

Encoder	0: 2 pole resolver Stegmann Hiperface Singleturn SRS 50/60 1024 increments A: per revolution Stegmann Hiperface Multiturn SRM 50/60 1024 increments B: per revolution Heidenhain EnDat Singleturn ECN 1113/1313 512 C: increments per revolution Heidenhain EnDat Multiturn EQN 1125/1325 512 increments D: per revolution Heidenhain Sin/Cos encoder ERN 1387 2048 increments per F: revolution Heidenhain Sin/Cos encoder ERN 1185 512 increments per H: revolution Heidenhain EnDat Singleturn ECI 1317 32 increments per I: revolution Heidenhain EnDat Multiturn EQI 1329 32 increments per J: revolution	
Connection	0: Plug/plug rotatable angular flange socket 1: Terminal box 9: Plug size 1,5	
Voltage	2: 190 V (200 V class)	4: 330 V (400V class)
Speed	1: 1500 ^{rpm} 2: 2000 ^{rpm} 3: 3000 ^{rpm}	4: 4000 ^{rpm} 6: 6000 ^{rpm}
Design	0: Feather key (default) 1: Feather key, brake (default) 2: without feather key 3: without feather key, brake 4: Feather key, oil-tight flange IP65 (radial shaft sealing ring) 5: Feather key, brake, oil-tight flange IP65 (radial shaft sealing ring) B: Oil-tight flange IP65 (radial shaft sealing ring) C: Brake, oil-tight flange IP65 (radial shaft sealing ring)	
Cooling	0: Self-cooling with flange B5 (1FT5 compatible) 1: Separate cooling with flange B5 (1FT5 compatible) 2: Self-cooling; foot 3: Separate cooling; foot	
Motor type	0: Three-phase synchronous motor Dynamic Line I	
Unit type	SM: Servo motor	
Size/construction length	A1...E3	

Product Description

2.2 Overview of the motor

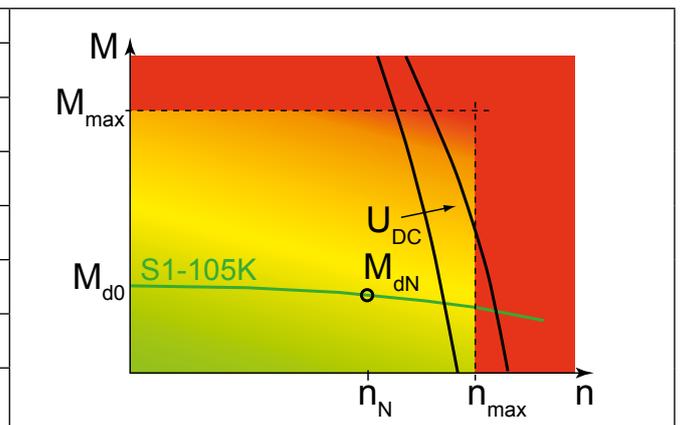
Motor type		Standstill-torque M_{d10} [Nm] at	Rated torque M_{dN} [Nm] dependent on the motor rated speed					
			10 rpm	1.000 rpm	2.000 rpm	3.000 rpm	4.000 rpm	6.000 rpm
200 V / 400 V	A1.SM.000	0.34					0.32	
	A2.SM.000	0.50					0.48	
	A3.SM.000	0.65					0.6	
	A4.SM.000	1.0					0.8	
	B1.SM.000	0.65				0.6	0.5	
	B2.SM.000	1.5				1.3	1.0	
	B3.SM.000	2.3				2.0	1.5	
	C1.SM.000	0.95				0.8	0.75	0.7
	C2.SM.000	2.7				2.4	2.2	2.0
	C3.SM.000	4.5				3.9	3.5	2.8
	C4.SM.000	6.0				5.0	4.5	3.0
	D1.SM.000	4.2				3.7	3.5	3.0
	D2.SM.000	7.0				6.1	5.8	3.8
	D3.SM.000	10.0				8.4	7.6	5.0
	D4.SM.000	12				9.9	8.6	
	E1.SM.000	8.5			7.0	6.5	5.2	
E2.SM.000	14.0			12.2	11.0	7.6		
E3.SM.000	19.0			16.5	14.6	8.7		
E4.SM.000	27.0			21.4	15.5			
400 V	F1.SM.000	25	22.5	21.5	20.0	16.0		
	F2.SM.000	50	42.0	38.0	31.0			
	F3.SM.000	70	61.0	52.0	33.0			

2.3 Standard design of the servo motors

	default	Option
Type	IM B5 (IM V1, IM V3)	
Degree of protection	IP 65	
Shaft gland	IP 64	IP 65
Motor type	Permanent-field synchronous servo motor	
Magnetic material	Neodymium iron boron	
Rated data	valid for S1- operation (continuous operation)	
Vibration severity level	B	
Flange accuracy	N	R
Insulation class	155 (F); Wire isolation in class 180 (H)	
Winding protection	Thermistor (PTC) 150°C (with strengthened isolation in accordance with EN 50178)	KTY 84; KTY 83; Miniature-bimetal switch
Power connection	Plug (rotatable, speedTEC - compatible)	
Encoder system connection	Plug (rotatable, speedTEC - compatible)	
Encoder system	Resolver	Sin-Cos absolute encoder
Cooling	Self-cooling	External cooling
Brake	–	permanent-field holding brake
Paint	RAL 9005 (matt-black)	
Storage	Radial groove ball bearings with lifetime lubrication	Size Ax...Dx: Fixed bearing on D side
		Size Ex: Fixed bearing on N side
Storage- lifetime	the average storage- lifetime on nominal rating conditions is 20.000 h	
Shaft end	smooth shaft end	Feather key (to DIN 6885) balanced with half-key
Surrounding temperature range	-20°C to +40°C	

2.4 Speed-torque characteristic

Definition	
M_{d0}	Stall torque (n=0)
M_{max}	max. torque
M_{dN}	Rated torque
I_{dN}	Rated current
n_N	Rated speed
n_{max}	max. speed
U_{DC}	DC link voltage



Product Description

2.5 Project design

2.5.1 Selection of the servo motor

Calculate the following values before you select the servo motor:

- Determine inertia (J_{App}) of the application without motor
- Calculate required peak torque (ML_{max}) of the application at the drive. The inertia of the motor (J_{Mot}) can be accepted here with 1/5 inertia (J_{App}) of the application.
- Determine the effective torque (M_{eff}) via the time.

Now the motor can be selected on the basis of the calculated values and the technical data of the following pages. The following selection features must be observed:

Calculated data of the application	Motor data
Maximum speed of the application (n_{max})	Rated motor speed (n_N)
required peak torque (M_{Lmax})	Maximum torque (M_{max})
Effective torque (M_{eff})	Rated torque (M_{dN})
Inertia of the application (J_{App}) / 10	Motor torque (J_{mot})

For examination or optimization it can be calculated again with the real motor data.

2.5.2 Selection the servo controller

The selection of the servo controller occurs via the max. short time current limit and the output rated current. Alternatively KEB provides the „motor configurator“ for registered users in Internet and Service&Downloads.

Max. short time current	=	$\frac{ML_{max} \cdot \text{Stall current } (I_{d0})}{\text{Stall torque } (Md0)}$
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Output rated current	=	$\frac{\text{Effective torque } (M_{eff}) \cdot \text{Stall current } (I_{d0})}{\text{Stall torque } (Md0)}$
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2.5.3 Output component

The smallest possible effective circular diameter of the output component can be calculated as follows:

$D_w = \frac{k \cdot 2 \cdot Mb}{F_{Rm}}$	D_w	effective circular diameter of the output components
	k	pretension factor
	F_{Rm}	permissible lateral force
	Mb	acceleration torque of the drive

2.5.4 Pretension factor

Empirical values for the pretension factor k:

Pinion	$k \approx$	1.5
Toothed belt		1.2...2.0
V-belt		1.5...2.5
Flat belt		2.2...3.0

For dynamic processes like braking and accelerating, the permissible lateral force FR is not to be exceeded in order to avoid a mechanical destruction of the motor.

2.6 Construction and definition

The servo motors of the SM.5 series are 6- or 8- pole permanent-field synchronous motors with a sine-wave inducted voltage. A new compact coil technique ensures a high power density of the motors.

2.6.1 Drive end and direction of rotation

<p>Drive end of the motor In DINEN60034-7, the two ends of a motor are defined as follows: D (Drive End): Drive end (AS) of the motor. N (Non-Drive End): Non-drive end (BS) of the motor.</p>	
<p>Direction of rotation of the motor When the motor terminals U1, V1, W1 are connected to the inverter output with U, V, W (with this same phase order) the motor rotates clockwise when viewed facing the D-end.</p>	

2.6.2 Shaft end and feather key

Motors of the SM.5 series have cylindrical shaft ends to DIN 748. As an option, the shaft end is also available with a keyway to DIN 6885, Part 1. Use suitable devices for mounting and pulling off driving elements such as gears, pulleys, couplings, etc. Support the device at the DE shaft end.

	<p>Use suitable tool Do not expose the motor to any impacts or blows.</p>
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	Shaft end		Feather key		
	Motor type	d1	L1	B	L2
Ax.SM.0	Ø 9 k6	20	3	12	4
Bx.SM.0	Ø 11 k6	23	4	16	3.5
Cx.SM.0	Ø 14 k6	30	5	22	4
Dx.SM.0	Ø 19 k6	40	6	32	4
Ex.SM.0	Ø 24 k6	50	8	32	4
Fx.SM.0	Ø 32 k6	58	10	50	4

Product Description

2.6.3 Winding and insulation system

The insulation materials we use ensure insulation class 155 (F) to EN60034. Therefore, the winding temperature rise may be max. 105K at a coolant temperature of +40°C. We also use insulation materials with the temperature profile TI 200 of class 180 (H) to increase the reliability of the motors.

The insulation system of the motors is designed such that they can be connected to an inverter with a maximum DC link voltage $U_{link\ max.} = 840\ VDC$ (constant 690VDC).

	$U_{link\ max.}$ is the maximum value of the DC link voltage which is only transient and approximately equivalent to the inception voltage of the braking shopper or of the regenerative unit.
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	No mains operation	The motors are not designed for direct connection to the three-phase system but are to be operated via an electronic power inverter. Direct connection to the system leads to the destruction of the motor.
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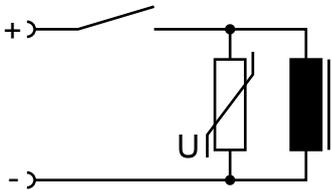
2.6.4 Holding brake (optional)

The optional built-in holding brake is used to fix the motor shaft when the motor is at standstill or de-energized. It is a permanent-field single-disc brake which operates on the closed-circuit principle, i.e. the brake is effective when the motor is de-energized, thus the motor shaft is held.

	Holding brake is not a working brake	Check the proper functioning of the brake (optional) after installing the motor. The optional holding brake is only designed for a limited number of emergency brakings. The use as a working brake is not permitted.
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Holding brakes are operated on DC current. The nominal voltage is 24 V. They can be connected to a central DC voltage supply. Overvoltages, even transient, are not permitted since they deteriorate the permanent magnets irreversibly. The excitation current ripple must be less than 20 % to ensure reliable opening of the brake and prevent disturbing humming noises.

	Motor rotation in spite of an active brake	Since the holding brakes are permanent-magnet brakes, be sure to observe the correct polarity of the DC voltage, otherwise the brake will not open. Modern (field-oriented) frequency inverters are able to produce a high torque even at low motor speeds. If the inverter has a sufficient current reserve, a multiple of the rated motor torque can be produced. In this case the motor shaft may turn even if the holding brake is applied, because the holding torque of the brake is exceeded.
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<p>If the excitation current of the holding brake is switched off on the DC side, a voltage peak occurs which can be higher than 1,000V. It is caused by the inductance of the holding brake. A varistor should be connected in parallel to the coil to prevent this voltage peak.</p> <p>Attention! On motors with plug connector and built-in brake, it is the user's responsibility to install the varistor provided to control the brake.</p>	
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2.6.5 Separately driven fan

The motors SM.51 are forced-air-cooled by an axial fan with a single-phase split motor. The connection data are given on the motor name plate. The necessary terminal plug is included in the delivery of the motor.

Motor type	Rated voltage	Rated current	Degree of protection
CxSM.51	230V (+10% / -10%) 50/60Hz	0.12A	IP 54
DxSM.51	230V (+10% / -10%) 50/60Hz	0.30A	IP 54
ExSM.51	3 x 400V (+10% / -10%) 50/60Hz	0.15A	IP 44

	Check external fan	If the motor has an external fan it must be connected proper and the direction of rotation is to be checked (arrow-direction of rotation to fan housing). The fan wheel may not be obstructed in its motion by exterior objects. The exhaust air of neighbouring units may not be sucked in again directly.
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2.6.6 Temperature monitoring

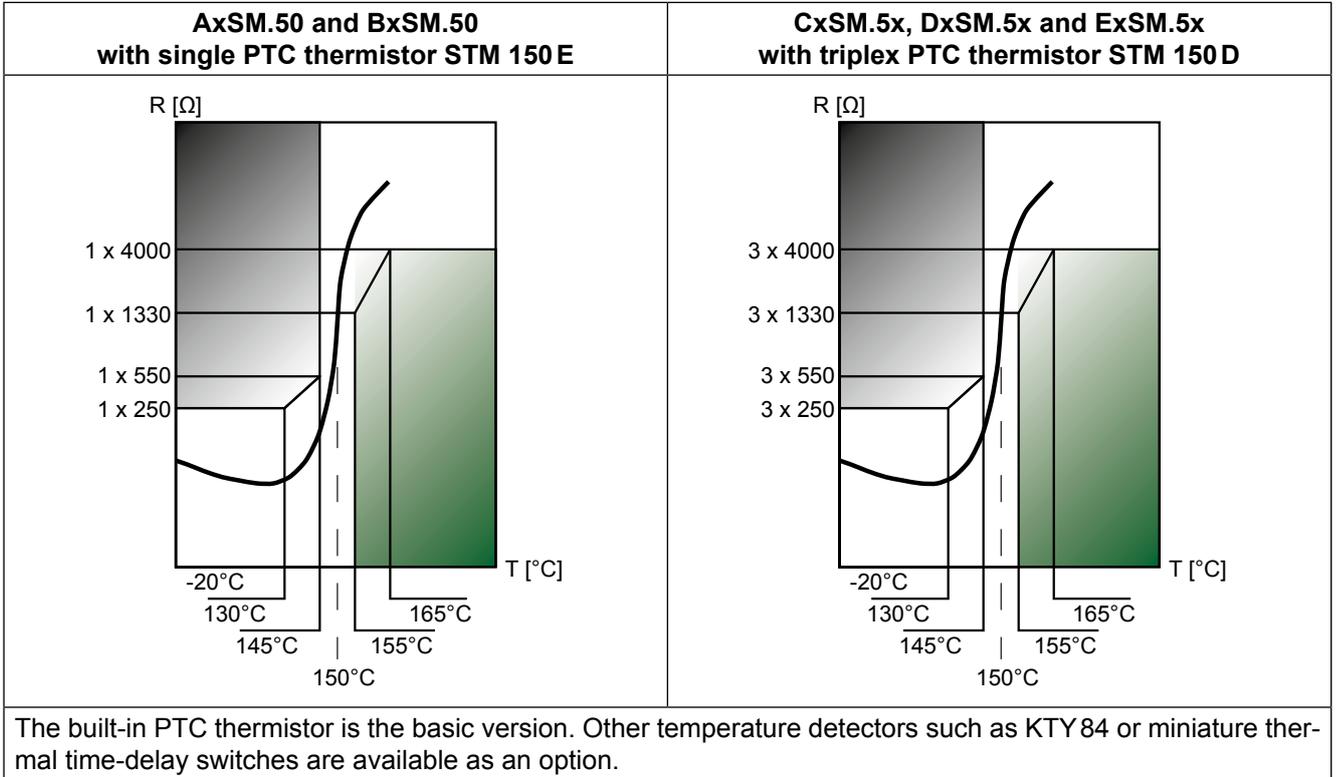
PTC thermistors are installed as standard in the NDE winding head to protect the motors against thermal overload when the temperature change is slow (temperature change in minutes or hours).

	max. 30VDC	The maximum operating voltage of the PTC thermistors must not exceed 30 VDC.
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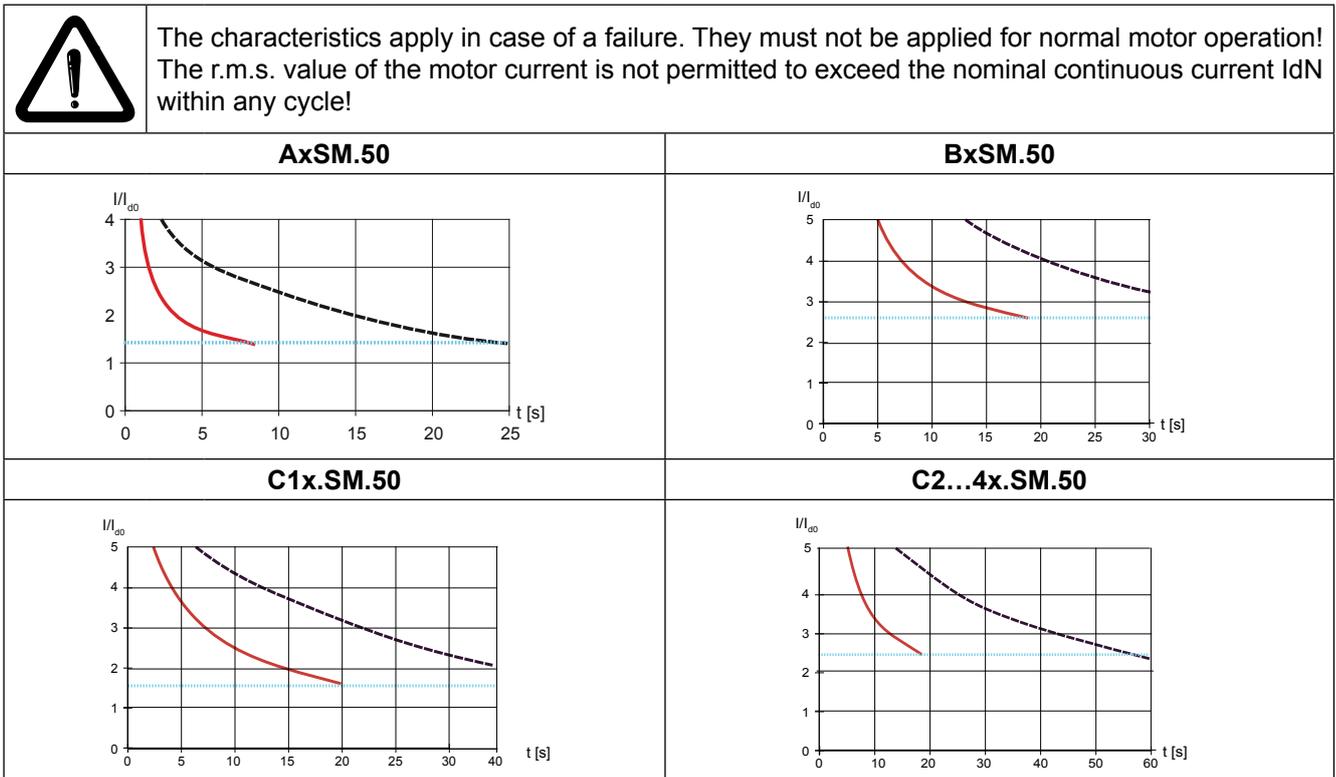
Due to the non-ideal thermal coupling, the temperature sensor follows rapid winding temperature changes only with delay, thus being unable to protect the winding if the thermal overload of the motor is transient and high. Therefore, additional protection is required (e.g. monitoring $I^2 \times t$ by the inverter electronic system) to protect the motor from fast-rising thermal overload.

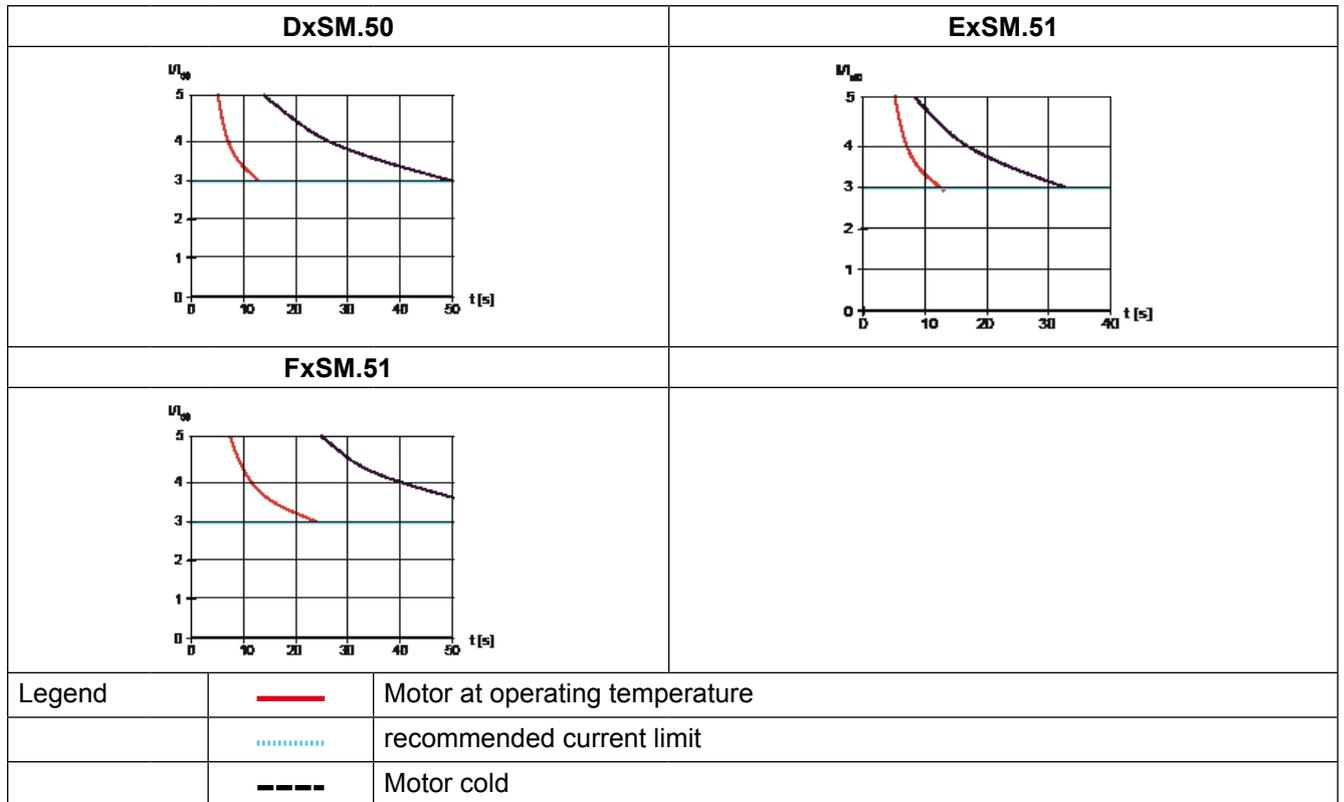
	Attention overload	The evaluation of the temperature sensor belongs to the monitoring of the motor winding. The temperature sensor follows fast temperature changes only with delay. Especially the windings of small motors (AxSM.50 and BxSM.50) are very sensitive to overload.
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Product Description



The maximum motor current must be limited to ensure that the temperature sensor trips quickly enough (see the following diagrams to adjust the recommended current limits). If a higher current limit needs to be adjusted, the current must not exceed the current-time values shown in the characteristics and the motor max. current I_{max} .





2.6.7 Speed and shaft position measuring system / resolver
 The SM.5 motors are equipped with 2-pole resolvers for speed and shaft position control.

Technical data of the resolver		
Number of poles	2	
Transformation ratio K	0.5 ±5%	
Input voltage/frequency	7 V / 10 kHz	
Input current	65 mA max.	
Electrical error	±10' max.	
Phase displacement	0° nom.	
S1	Cos high	red
S2	Sin high	yellow
S3	Cos low	black
S4	Sin low	blue
R1	Excitation high	red/white
R2	Excitation low	black/white or yellow/white

$$U_{S1-S3} = K * U_{R1-R2} * \cos \alpha$$

$$U_{S2-S4} = K * U_{R1-R2} * \sin \alpha$$

	Adjustment of the measuring system	The measuring system of synchronous motors must be adjusted to the respective inverter. Any mis-adjustment may lead to uncontrolled motor response or complete failure of the motor.
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Other resolver pole numbers or other measuring systems are available (e.g. absolute encoder; SIN-COS coder or Encoder).

Operating Conditions

3. Operating Conditions

3.1 Degree of protection

The motors SM.5 series are generally designed to meet degree of protection IP 65 as specified in DIN EN 60034-5 (option separately driven fan: IP 54). See table below for the respective sealing.

Shaft sealing	Degree of protection	User information
Grease-packed groove (standard)	IP 64	The effect to moisture in the shaft and flange area must be kept to a minimum. No liquid may remain in the D end shield, if the motor is mounted with the "shaft end upward" (IM V3, IM V36).
Rotary shaft seal (Option)	IP 65	Suitable for the installation of non-sealed gear units to seal against oil.

	Lubrication of the rotary shaft seal	<p>When using a rotary shaft seal, note that the sealing lip needs to be sufficiently lubricated and cooled with a high-quality mineral oil such as SAE 20 to ensure the proper functioning of the seal. Sufficient lubricant supply is required for proper heat dissipation.</p> <p>If the shaft seal is greased, the maximum permissible motor speed may need to be reduced.</p> <p>Regular regreasing is imperative!</p> <p>Excessive peripheral speeds destroy the sealing lip and its protective function is no longer guaranteed.</p>
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3.2 Cooling, altitude, ambient conditions

<p>The rated power (rated torque) applies to continuous operation (duty type S1) at a coolant temperature of 40°C and an altitude of up to 1,000 m above sea level. It is determined by using defined aluminium test flanges (see table opposite).</p> <p>Larger mounting flanges improve the heat dissipation conditions whereas smaller flanges deteriorate them. Since a large number of influencing factors have to be taken into account no reliable estimation of the required power reduction can be made.</p> <p>If the motor flange is thermally insulated, it is not able to dissipate the motor heat. This requires a reduction of the rated motor torque.</p>	Motor type	Test flange dimensions					
	55	200 x 100 x 10					
	70	230 x 150 x 15					
	92	230 x 150 x 15					
	110	230 x 150 x 15					
	140	300 x 300 x 20					
	190	300 x 300 x 20					
<p>At higher temperatures or altitudes, the overload capability of the motors is reduced (see table opposite).</p>	Altitude above sea level [m]	Coolant temperature [°C]					
		<30	30-40	45	50	55	60
	1000	1.07	1.00	0.96	0.92	0.87	0.82
	1500	1.04	0.97	0.93	0.89	0.84	0.79
	2000	1.00	0.94	0.90	0.86	0.82	0.77
	2500	0.96	0.90	0.86	0.83	0.78	0.74
	3000	0.92	0.86	0.82	0.79	0.75	0.70
	3500	0.88	0.82	0.79	0.75	0.71	0.67
4000	0.82	0.77	0.74	0.71	0.67	0.63	

	Fire- and combustion protection	<p>The motors can reach a surface temperature of more than 100°C. No temperature-sensitive parts may lay close to or be attached onto the motor. If necessary, protective measurements must be taken against touching.</p>
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	Derating due to harmonics	A derating can be necessary due to different clock frequencies of the power stages of the inverters and the associated different losses by the current harmonics.
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3.3 Permissible axial and radial forces

The maximum permissible axial and radial forces must not be exceeded in order to ensure smooth running of the motor.

3.3.1 Table

Indicated in the table:

- the highest permissible lateral force F_{Rm} at $x=L/2$
- the highest permissible axial force F_{Am} for a lifetime of 20.000 hours.

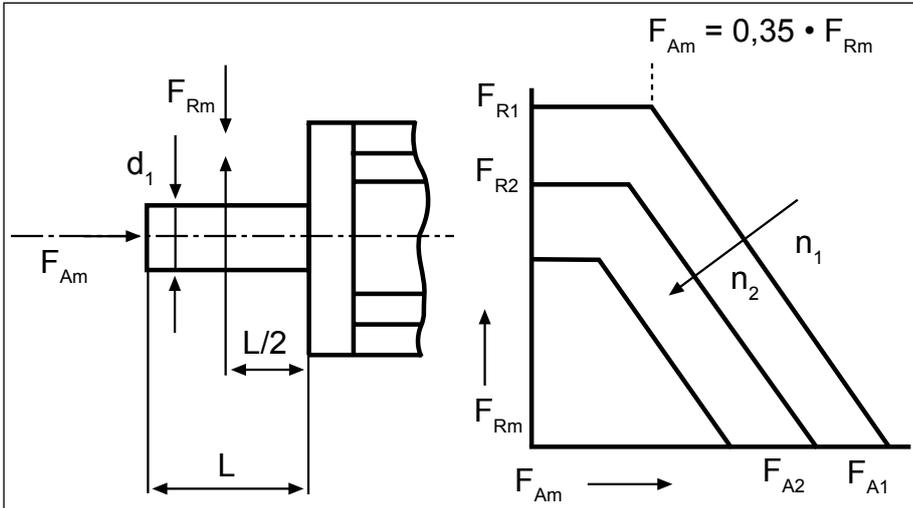
Motor	Lateral force F_{Rm} [N] at speed n [rpm]				Axial force F_{Am} [N] at speed n [rpm]				d_1 L	F_G [N]	P [mm]	C [mm]	F_{Rmax} [N]
	2000	3000	4000	6000	2000	3000	4000	6000					
A1	310	260	240	210	250	200	170	140	9 k6 20	1	10	96	600
A2										2		108	
A3										3		121	
A4										4		145	
B1	400	340	300	270	310	260	220	180	11 j6 23	2	11	81	800
B2										4		105	
B3										6		141	
C1	470	400	350	320	380	310	260	220	14 k6 30	3	17	131	1000
C2										9		155	
C3										14		189	
C4										20		223	
D1	720	640	550	490	590	500	420	350	19 k6 40	10	24	138	2000
D2										17		168	
D3										23		198	
D4										30		228	
E1	1100	1000	850	-	900	770	650	560	24 k6 50	17	24	188	2300
E2										30		218	
E3										40		248	
E4										60		293	
F1	2300	1900	1800	-	1800	1500	1400	-	32 k6 58	85	31	280	6000
F2										140		360	
F3										200		440	

F_{Rm}	permissible lateral force	L	Length of the shaft end
F_{Rmax}	max. permissible dynamic lateral force	F_G	Inertial force of the rotor
F_{Am}	permissible axial force	P	Linear size P
d_1	Shaft diameter	C	Linear size C

Operating Conditions

3.3.2 Shaft strain

The endurance strength of the shaft and the lifetime of the bearing determine the permissible lateral force F_{Rm} at the Drive-End -side shaft end



3.3.3 Output component

The minimum effective pulley diameter of the driving element is calculated as follows:

$D_w = \frac{k \cdot 2 \cdot M_b}{F_{Rm}}$	D_w : Effective pulley diameter of the driving element k : preloading factor F_{Rm} : permissible radial force M_b : acceleration torque of the drive
--	--

3.3.4 Preloading factor

Empirical values for the preloading factor k :

approx. $k = 1.5$	for pinion
approx. $k = 1.2$ to 2.0	for toothed belt
approx. $k = 2.2$ to 3.0	for flat belt

For dynamic processes like braking and accelerating, the permissible radial force F_R is not to be exceeded in order to avoid a mechanical destruction of the motor.

3.3.5 Horizontal standard

If the lateral force F_R is not applied at $x = L/2$, different radial forces will arise:	$F_{Rx} = F_{Rm} \cdot \frac{c + p + 0,5 \cdot L}{c + p + x}$
If the axial force F_{AR} is not applied at the shaft centre, its radial component is taken into consideration by using:	$F_{AR} = F_{AY} \cdot \frac{y}{p + x}$
<p>The diagram shows a shaft with a motor on the right. A horizontal force F_{AR} is applied at a distance y from the shaft centerline. A horizontal force F_{Ay} is applied at the shaft centerline. Two vertical forces, F_{Rx} and F_{Rm}, are applied to the shaft. F_{Rm} is applied at a distance $L/2$ from the motor center. F_{Rx} is applied at a distance x from the motor center. The total length of the shaft is L. The motor has a length p and a distance c from the motor center to the end of the shaft.</p>	

3.3.6 Vertical standard

If the motor is mounted vertically, the permissible axial forces F_{Am} (see table) are understood as acting upward.	$F_{Am/new} = F_{Am} - F_G$
If the forces act downward, the level of permissible axial forces F_{Am} is reduced by the rotor forces of gravity F_G :	$F_G = mL \cdot g$
If the axial force F_{Am} acts away from the motor, a force F_w has to be taken into account for safety reasons:	$m_L: \text{rotor weight}$ $g: \text{gravitation acceleration}$ $F_{Am/new} = F_{Am} - F_G - F_w$ $F_w [N] = 10 \times d_1 [\text{mm}]$
<p>The left diagram shows a shaft with a downward force F_G and an upward force F_{Am}. The right diagram shows a motor mounted vertically with a downward force F_G and an upward force F_{Am}.</p>	
Motors of the series A1... F3 with built-in holding brake are not to be loaded with axial forces, since the working airgap of the holding brake is changed and the holding brake becomes inoperative by it.	

Connection

4. Connection



The connection must be carried out in such a way that a permanently safe, electrical connection is maintained. Pay attention to a safe protective conductor connection. By turning the flange sockets any outgoing cable direction can be adjusted (rotatable by 90° each).
In the case of improper execution of the work the type of protection IP65 is no longer warranted. If connector systems are used, then the type of protection IP65 is only achieved with correctly wired and firmly tightened mating connector.

4.1 Conductor cross-section

The recommended values for the dimensioning of the conductor cross-sections are given in the table. They are specified in DIN VDE 0113 (EN 60 204) „Electrical equipment of industrial machines“ for the current carrying capacity of PVC-insulated cables with copper conductor routed in cable ducts. The maximum permissible surrounding temperature is +40°C.

Conductor size [mm ²]	perm. maximum current (actual value) [A]
1.5	13.5
2.5	18.3
4	24

4.2 Power unit

Power unit connection	Ax...Dx.SM.5		Ex.SM.5	
<ul style="list-style-type: none"> • Angle socket • rotatable • 8-pole • Plug 				
View of the connector pins at the motor				
Terminal assignment	1	U	U	U
	2	PE	V	V
	3	W	W	W
	4	V	\perp	PE
	A	Brake + (option)	+	Brake + (option)
	B	Brake - (option)	-	Brake - (option)
	C	Temperature detector +	1	Temperature detector +
	GB	Temperature detector -	2	Temperature detector -
Motor cable for	Ax...Dx.SM.5		Ex.SM.5	
ready-made, shielded, trailing capable	00S4x19-yyyy		00S4x19-yyyy	
	x - cross-section [mm ²] 0 = 1.5 mm ² ; 1 = 2.5 mm ²		x - cross-section [mm ²] 2 = 4 mm ²	
	yyyy - line length [m]			

4.3 Encoder connection

4.3.1 Resolver

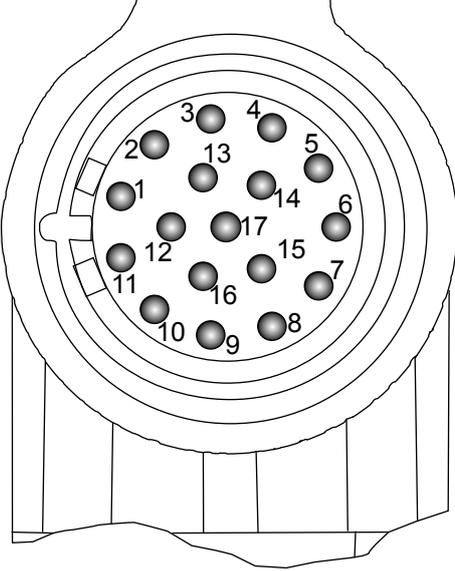
Resolver connector	View	No.	Signal	Color
<ul style="list-style-type: none"> • Angle socket • rotatable • 12-pole • Plug 		1	SIN-	red
		2	COS+	pink
		5	REF+	yellow
		7	REF-	green
		10	SIN+	blue
		11	COS-	grey
View of the connector pins at the motor		All other contacts are not assigned.		
Encoder cable	A-Servo 00F50C1-0yyy	F5-Multi 00F50C1-1yyy		
ready-made, shielded, trailing capable, yyy - line length [m]				

4.3.2 Hiperface

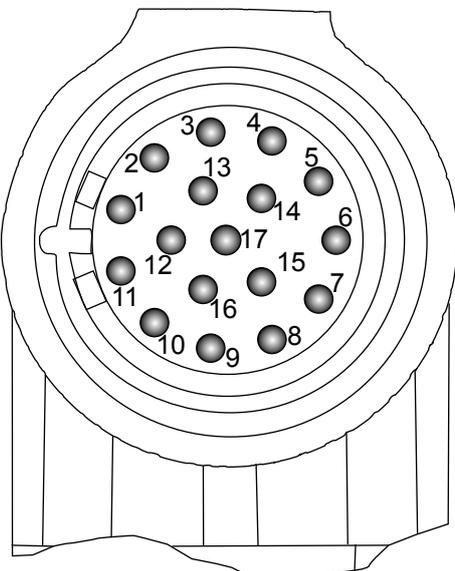
Hiperface connector	View	No.	Signal	Color	
<ul style="list-style-type: none"> • Angle socket • rotatable • 12-pole • Plug 		4	REF_SIN-	red	
		5	REF_COS-	yellow	
		6	Data+	grey	
		7	Data-	pink	
		8	SIN+	blue	
		9	COS+	green	
		10	+7.5V	brown	
		11	COM	white	
View of the connector pins at the motor		All other contacts are not assigned.			
Encoder cable		F5-Multi 00S4809-yyyy			
ready-made, shielded, trailing capable, yyyy - line length [m]					

Connection

4.3.3 EnDat

EnDat-connector	View	No.	Signal	Color		
• Angle socket		7	+5V	white		
• rotatable		8	Clock+	black		
• 17-pole		9	Clock-	purple		
• Plug		10	COM	brown		
View of the connector pins at the motor		12	B+	blue		
		13	B-	red		
		14	Data+	grey		
		15	A+	green		
		16	A-	yellow		
		17	Data-	pink		
		All other contacts are not assigned.				
		Encoder cable	00F50C1-yyyy			
		ready-made, shielded, trailing capable, yyyy - line length [m]				

4.3.4 SIN/COS

SIN/COS-connector	View	No.	Signal	Color	
• Angle socket		1	A+	green	
• rotatable		2	A-	yellow	
• 17-pole		3	R+	grey	
• Plug		4	GB -	purple	
View of the connector pins at the motor		5	C+	white	
		6	C-	brown	
		7	COM	white/green	
		10	+5V	grey/pink	
		11	B+	blue	
		12	B-	red	
		13	R-	pink	
		14	D+	black	
		All other contacts are not assigned.			
		Encoder cable	00S4209-yyyy		
ready-made, shielded, trailing capable, yyyy - line length [m]					

4.4 Separate ventilator connection

Separate ventilator connection	Ax...Dx.SM.5			Ex.SM.5		
View of the connector pins at the motor						
Terminal assignment	1	L1	1 x 230 V AC	1	U	3 x 400 V AC
	2	N		2	V	
		PE	Protective conductor	3	W	
					PE	Protective conductor

5. Start-up

5.1 Preparations

Before initial operation and after major inspections, check the complete plant both from a mechanical and electrical point of view.

Examine that

- the installation and the operating conditions comply with the specified name plate data.
- the motor is properly installed and aligned.
- the driving elements are properly adjusted (e.g. proper belt tension, coupling properly aligned and balanced),
- the motor and its monitoring devices are properly wired.
- the earthing and equipotential bonding have been made as specified in the applicable regulations.
- all fastening screws, connecting elements and electrical connections are properly tightened.
- the key is saved unless prevented otherwise by driving elements such as pulleys, couplings etc.
- the separate ventilation is correctly connected and in proper service condition.
- the direction of rotation of the fan motor corresponds with the direction arrow on the fan housing.
- the cooling air flow is not impaired (the hot outlet cooling air must not be drawn in by the fan!).
- eventually existing brakes are O.K.

5.2 Initial start-up

The following measures are recommended to be taken after installing or inspecting the motors:

- Start the motor with no load.
- Check the mechanical running for any noise or vibrations on the bearings or end shields.
- If there is any abnormal noise or the motor runs unevenly, switch it off immediately and find out the cause.
- If the mechanical running improves immediately after the motor has been switched off, there is an electrical or magnetic cause. If this is not the case, there is a mechanical cause.
- If the mechanical running is smooth at no load, load the motor. Check the running smoothness, measure the voltage, current and power and record them. Measure and record these values also for the driven equipment, if possible.
- Monitor the temperatures of the bearings, windings etc. until they have stabilised and record the values (as far as this is possible with the available measuring equipment).

5.3 Operation

In case of changes as compared to the normal operation, e.g. increased temperature, noises, oscillations, find out the cause. In case of doubt switch off the motor!

6. Maintenance and repair

Careful and regular maintenance and inspections are required to recognise and remedy troubles in good times, before they lead to major damage.

	<p>Repairs</p>	<p>Repairs may be carried out only by the manufacturer or repair places authorized by him. Unauthorised opening and tampering may lead to bodily injury and property damage and may entail the loss of warranty rights.</p>
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6.1 Maintenance intervals

	<p>Safety at maintenance</p>	<p>Before starting any work on the motors, and particularly before opening any covers of active parts, make sure that the motor and plant have been properly isolated. This refers also to any additional or auxiliary circuits! The „5 safety rules“ to be applied according to DIN VDE 0105 are:</p> <ul style="list-style-type: none"> • Disconnect the motor • Secure against restarting • Verify the safe isolation from supply • Earth and short (at voltages above 1000V) • Safeguard or cover adjacent live parts.
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Since the operating conditions of the motors differ considerably, only general maintenance intervals to ensure trouble-free operation can be specified. They need to be adapted to the local conditions such as the actual level of contamination, numbers of starts, load, etc. The radial groove ball bearings of the motor are lubricated for life and are designed for nominal service life of 20,000 hours. Motors with shaft sealing ring must be mounted together with gears which prevent dry running of the shaft sealing ring. Otherwise it comes to screeching noises and overheating of the motor by increased friction.

<ul style="list-style-type: none"> • 	<p>depending on the local level of contamination</p>	<p>Clean the motor</p>
<ul style="list-style-type: none"> • 	<p>depending on the operating mode every 50 to 500 operating hours</p>	<p>Regrease the optional rotary shaft seal ring (applies only to grease lubrication!)</p>
<ul style="list-style-type: none"> • 	<p>after approx. 500 operating hours, but after 1 year at the latest</p>	<p>Retighten the electrical and mechanical connections Check for deterioration of running smoothness or bearing noise.</p>

Technical Data

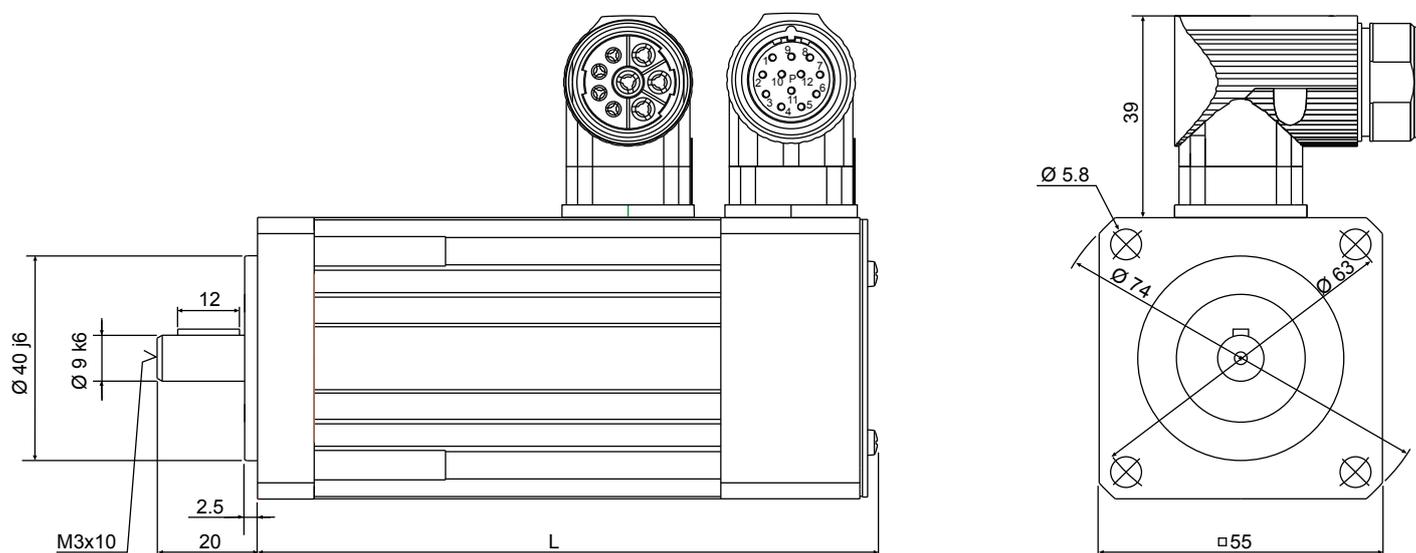
7. Technical Data

7.1 Self-cooling

Servo motor		Ax.SM.000-yyyy							
Speed and voltage variant (y)	Size (x)	A1		A2		A3		A4	
		6200	6400	6200	6400	6200	6400	6200	6400
Stall torque Md0	Nm	0.34		0.50		0.65		1.0	
Current at stall torque Id0	A	1.2	0.85	1.50	1	2	1.2	3.2	1.6
Nominal rating									
Rated voltage UN	V	230	400	230	400	230	400	230	400
Rated torque MN	Nm	0.32		0.48		0.6		0.8	
Rated current IN	A	1.0	0.8	1.5	0.9	2.0	1.1	2.9	1.4
Rated speed nN	rpm	6000		6000		6000		6000	
Rated power PN	W	200		300		375		500	
Voltage constant kE 1)	V/1000rpm	28.3	39.0	28.3	46.4	28.3	49.8	28.3	56.6
Winding resistance Ru-v	Ohm	21	40.5	8.7	25.8	6.1	18.9	3.3	13.1
Winding inductance Lu-v	mH	9.9	18.7	5.4	14.5	3.9	12.2	2.7	10.7
Maximum values									
max. torque Mmax	Nm	1.7		2.5		3.2		5.0	
max. current Imax	A	7.1	5.0	9.0	6.0	10.8	6.5	17.0	8.5
Mechanical data 2)									
Inertia JL	kgcm ²	0.17		0.24		0.31		0.45	
Weight	kg	1.0		1.2		1.4		1.8	

1) Peak value of motor EMC at 1000 rpm specified as phase-to-phase voltage.

2) With resolver; without holding brake



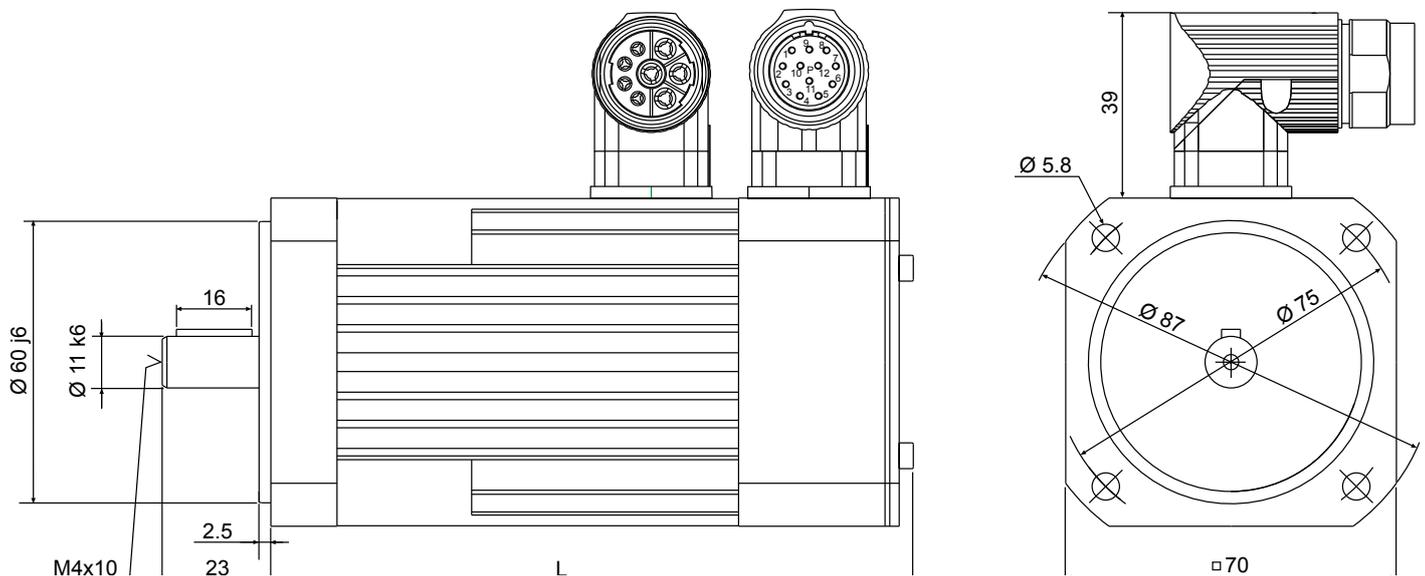
Length L

Design system	without brake		with brake	
	Resolver	SIN/COS	Resolver	SIN/COS
Encoder	–	ERN 1185	–	ERN 1185
Size	–	ERN 1185	–	ERN 1185
A1	121	156	145	180
A2	133	168	157	192
A3	145	180	169	204
A4	170	205	194	229

Servo motor		Bx.SM.000-yyyy											
Size (x) Speed and voltage variant (y)		B1				B2				B3			
		4200	4400	6200	6400	4200	4400	6200	6400	4200	4400	6200	6400
Stall torque M_{d0}	Nm	0.65				1.5				2.3			
Current at stall torque I_{d0}	A	1.9	0.9	2.6	1.3	3.2	1.6	5.0	2.4	5.5	2.4	7.7	3.5
Nominal rating													
Rated voltage U_N	V	230	400	230	400	230	400	230	400	230	400	230	400
Rated torque M_N	Nm	0.6		0.5		1.3		1.0		2.0		1.5	
Rated current I_N	A	2.0	0.9	2.5	1.2	2.9	1.4	4.4	2.1	4.7	2.0	6.6	3.0
Rated speed n_N	rpm	4000		6000		4000		6000		4000		6000	
Rated power P_N	W	250		310		540		620		830		940	
Voltage constant k_E ¹⁾	V/1000rpm	29.4	67.7	21.8	45.4	39.2	80.9	25.2	53.0	37.2	85.4	26.3	59.1
Winding resistance R_{U-V}	Ohm	6.8	39.5	3.8	17	4	17.3	1.6	7	1.7	9.2	0.83	4.2
Winding inductance L_{U-V}	mH	11.5	61.1	6.3	27.4	11.5	48.8	4.8	21.0	5.6	29.4	2.8	14.1
Maximum values													
max. torque M_{max}	Nm	3.1				7.2				11.0			
max. current I_{max}	A	11.4	5.4	15.6	7.8	19.2	9.6	30.0	14.4	33.0	14.4	46.2	21.0
Mechanical data ²⁾													
Inertia J_L	kgcm ²	0.22				0.36				0.57			
Weight	kg	1.5				2.1				2.9			

1) Peak value of motor EMC at 1000 rpm specified as phase-to-phase voltage.

2) With resolver; without holding brake



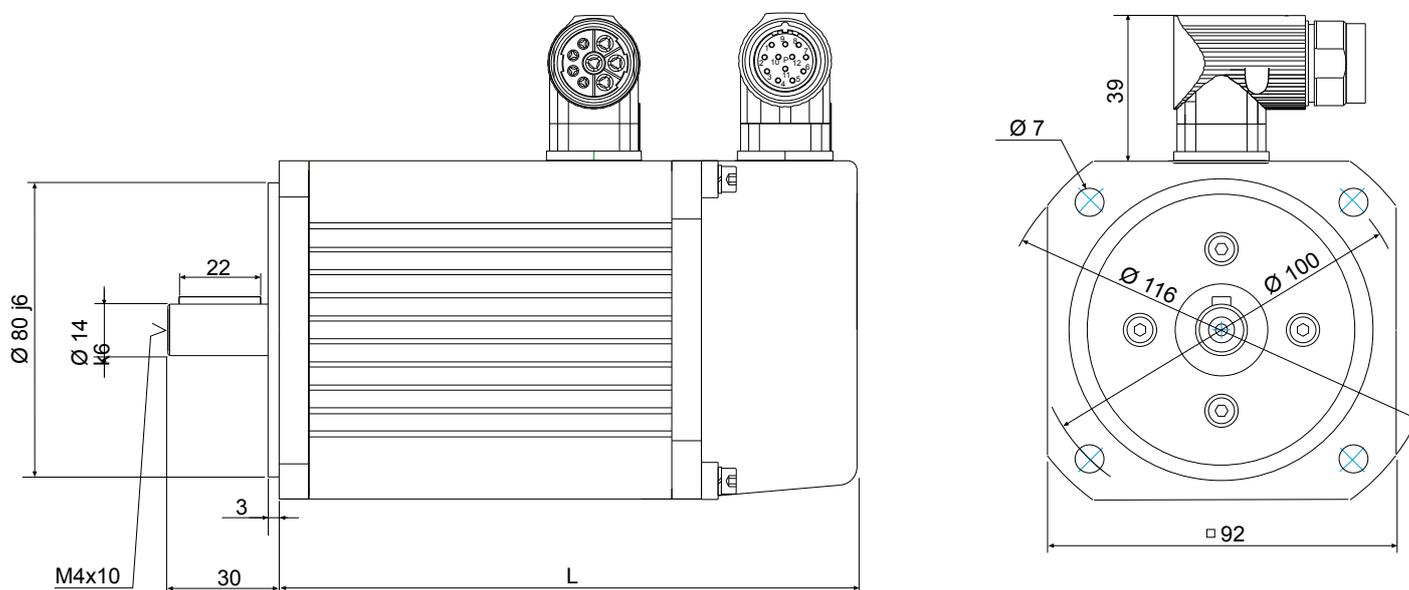
Length L										
Design system	without brake					with brake				
Encoder	Resolver	SIN/COS	EnDat	Hiperface		Resolver	SIN/COS	EnDat	Hiperface	
Size	-	ERN 1185	EQI	SRS/M 50	SRS/M 50/52K	-	ERN 1185	EQI	SRS/M 50	SRS/M 50/52K
B1	136	167	185	177	168	164	195	213	205	196
B2	160	191	209	201	192	188	219	237	229	220
B3	196	227	245	237	228	224	255	273	265	256

Technical Data

Servo motor		Cx.SM.000-yyyy									
Size (x)		C1					C2				
Speed and voltage variant (y)		3200	3400	4200	4400	6200	6400	3200	3400	4200	4400
Stall torque M_{d0}	Nm	0.95					2.7				
Current at stall torque I_{d0}	A	1.5	0.8	2.0	1.1	3.0	1.6	3.2	1.9	4.3	2.5
Nominal rating											
Rated voltage U_N	V	230	400	230	400	230	400	230	400	230	400
Rated torque M_N	Nm	0.8		0.75		0.7		2.4		2.2	
Rated current I_{dN}	A	1.4	0.75	1.8	0.9	2.4	1.3	3.0	1.8	3.6	2.1
Rated speed n_N	rpm	3000		4000		6000		3000		4000	
Rated power P_N	kW	0.25		0.31		0.44		0.75		0.92	
Voltage constant k_E ¹⁾	V/1000rpm	51.6	94.0	38.9	71.0	25.9	47.5	64.3	111.0	48.5	83.4
Winding resistance R_{U-V}	Ohm	20.5	74.9	12.1	39.4	5.1	18.9	4.2	13.1	2.3	6.9
Winding inductance L_{U-V}	mH	30.5	101	17.1	57.6	7.6	25.9	11.4	34.4	6.5	19.3
Maximum values											
max. torque M_{max}	Nm	4.3					12.2				
max. current I_{max}	A	7.5	4.0	10.0	5.4	15.0	8.0	16.0	9.4	21.5	12.4
Mechanical data ²⁾											
Inertia J_L	kgcm ²	1.2					2.7				
Weight	kg	2.7					3.9				

¹⁾ Peak value of motor EMC at 1000 rpm specified as phase-to-phase voltage.

²⁾ With resolver; without holding brake



Length L										
Design system	without brake					with brake				
Encoder	Resolver	SIN/COS	EnDat	Hiperface		Resolver	SIN/COS	EnDat	Hiperface	
Size	-	ERN 1387	EQI	SRS/M 50	SRS/M 50/52K	-	ERN 1387	EQI	SRS/M 50	SRS/M 50/52K
C1	156	193	193	163	173	192	229	229	199	209
C2	180	217	217	187	197	226	263	263	233	243
C3	214	251	251	221	231	260	297	297	267	277
C4	248	285	285	255	265	294	331	331	301	311

Cx.SM.000-yyyy

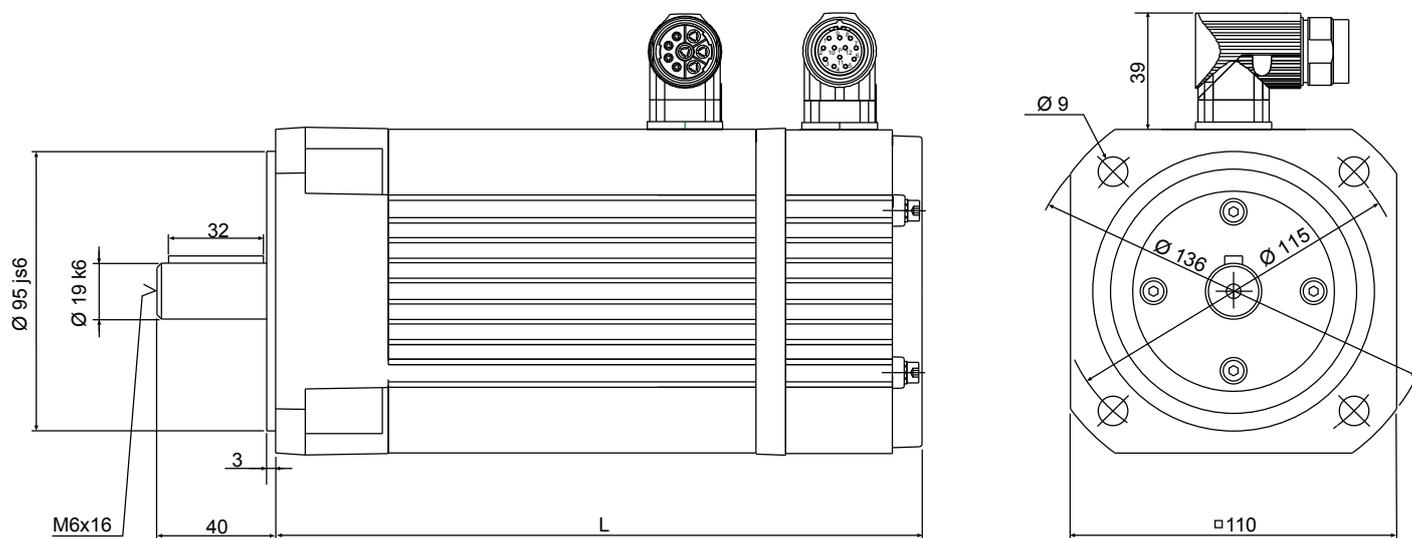
C2		C3						C4					
6200	6400	3200	3400	4200	4400	6200	6400	3200	3400	4200	4400	6200	6400
2.7		4.5						6					
6.5	3.7	5.1	2.9	6.7	3.8	9.9	5.6	7.1	4.2	9.1	5.5	13.7	7.8
230	400	230	400	230	400	230	400	230	400	230	400	230	400
2.0		3.9		3.5		2.8		5.0		4.5		3.0	
5.3	3.0	4.6	2.7	5.5	3.1	6.7	3.8	6.3	3.7	7.3	4.4	7.9	4.5
6000		3000		4000		6000		3000		4000		6000	
1,25		1.22		1.47		1.76		1.57		1.88		1.88	
33.0	55.7	69.4	118.0	52.6	90.8	35.4	61.4	67.7	113.0	53.0	86.7	34.9	60.1
0.95	3.3	2	5.9	1.1	3.7	0.54	1.7	1.2	3.4	0.74	2.1	0.32	1.03
2.7	8.6	6.9	20.6	4	12.2	1.8	5.7	4.5	13.1	2.8	7.8	1.2	3.8
12,2		20.3						27.0					
32.5	18.5	25.5	14.5	33.4	19.0	49.5	27.9	35.5	21.0	45.5	27.5	68.4	39.0
2.7		4.2						5.4					
3.9		5.2						6.6					

Technical Data

Servo motor		Dx.SM.000-yyyy									
Size (x)		D1						D2			
Speed and voltage variant (y)		3200	3400	4200	4400	6200	6400	3200	3400	4200	4400
Stall torque M_{d0}	Nm	4.2						7			
Current at stall torque I_{d0}	A	5.3	3.0	7.0	4.0	10.2	6.0	8.5	4.8	11.6	6.4
Nominal rating											
Rated voltage U_N	V	230	400	230	400	230	400	230	400	230	400
Rated torque M_N	Nm	3.7		3.50		3.0		6.1		5.8	
Rated current I_N	A	4.9	2.80	6.1	3.5	8.2	4.8	8.1	4.5	10.5	5.8
Rated speed n_N	rpm	3000		4000		6000		3000		4000	
Rated power P_N	kW	1.2		1.5		1.9		1.9		2.4	
Voltage constant k_E ¹⁾	V/1000rpm	66.5	117.0	50.5	87.7	34.5	58.4	66.9	119.8	48.9	89.0
Winding resistance R_{U-V}	Ohm	2.1	6.3	1.2	3.9	0.55	1.6	1	3.2	0.5	1.7
Winding inductance L_{U-V}	mH	7.7	23.8	4.5	13.4	2.1	6	4	12.8	2.2	7.05
Maximum values											
max. torque M_{max}	Nm	18.9						31,5			
max. current I_{max}	A	25.4	14.4	33.6	19.2	48.9	28.8	40.8	23.0	55.7	30.7
Mechanical data ²⁾											
Inertia J_L	kgcm ²	4.8						7.4			
Weight	kg	6.3						7.9			

¹⁾ Peak value of motor EMC at 1000 rpm specified as phase-to-phase voltage.

²⁾ With resolver; without holding brake



Length L										
Design system	without brake					with brake				
Encoder	Resolver	SIN/COS	EnDat	Hiperface		Resolver	SIN/COS	EnDat	Hiperface	
Size	-	ERN 1387	EQI	SRS/M 50	SRS/M 50/52K	-	ERN 1387	EQI	SRS/M 50	SRS/M 50/52K
D1	218	248	248	225	248	225	255	255	232	255
D2	248	278	278	255	278	255	285	285	262	285
D3	278	308	308	285	308	285	315	315	292	315
D4	308	338	338	315	338	315	345	345	322	345

Dx.SM.000-yyyy

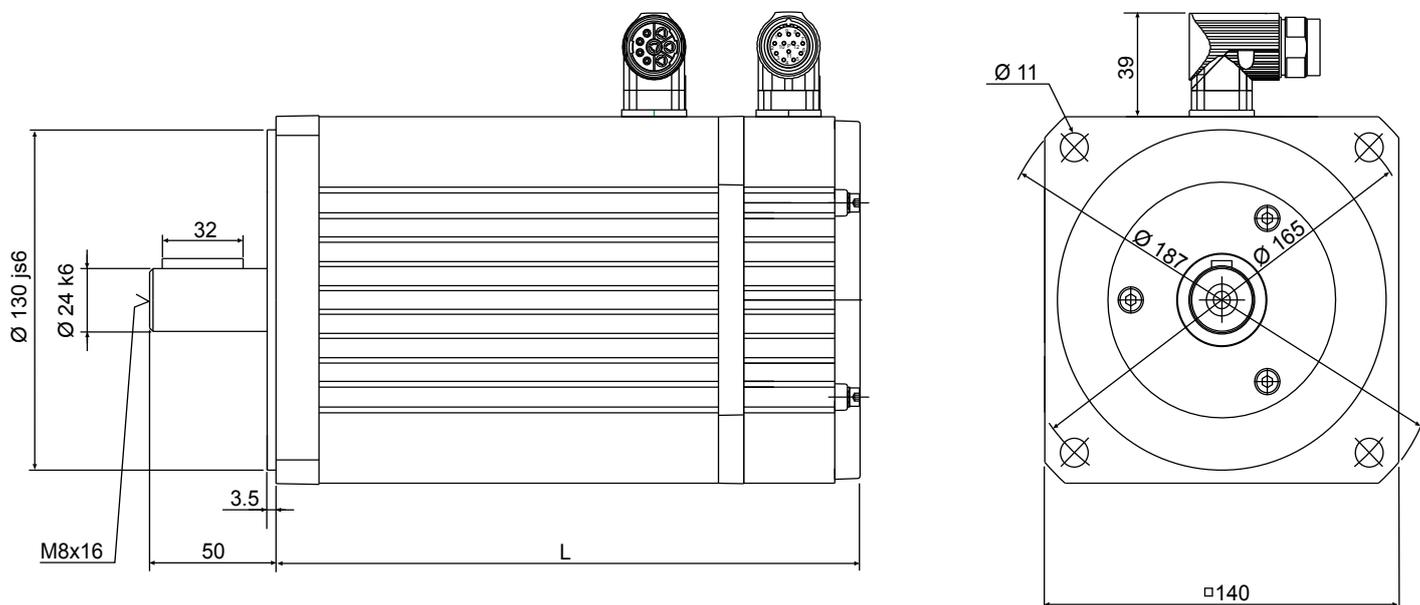
D2		D3						D4			
6200	6400	3200	3400	4200	4400	6200	6400	3200	3400	4200	4400
7		10						12			
16.0	9.9	12.4	7.2	17.0	9.7	22.6	13.6	14.2	8.5	18.2	11.6
230	400	230	400	230	400	230	400	230	400	230	400
3.8		8.4		7.6		5.0		9.9		8.6	
9.6	5.9	10.9	6.3	13.5	7.7	12.7	7.6	12.2	7.3	13.5	8.6
6000		3000		4000		6000		3000		4000	
2.4		2.6		3.2		3.1		3.1		3.6	
35.5	57.8	69.3	119.8	50.5	88.2	37.9	63.1	73.1	121.5	56.7	89.2
0.27	0.7	0.6	1.9	0.33	1.04	0.18	0.57	0.5	1.4	0.3	0.76
1.1	3.0	2.8	8.3	1.5	4.5	0.83	2.3	2.4	6.7	1.5	3.6
31.5		45.0						54.0			
76.8	47.5	59.5	34.5	81.6	46.5	108.0	65.3	68.1	40.8	87.3	55.7
7.4		9.8						12.7			
7.9		9.6						11.2			

Technical Data

Servo motor		Ex.SM.000-yyyy									
Size (x)		E1					E2				
Speed and voltage variant (y)		2200	2400	3200	3400	4200	4400	2200	2400	3200	3400
Stall torque M_{d0}	Nm	8.5					14				
Current at stall torque I_{d0}	A	5.3	3.1	8.0	4.7	10.7	6.2	8.6	4.7	13.3	7.5
Nominal rating											
Rated voltage U_N	V	230	400	230	400	230	400	230	400	230	400
Rated torque M_N	Nm	7.0		6.5		5.2		12,2		11.0	
Rated current I_N	A	4.4	2.6	6.4	3.8	6.9	4.0	7.5	4.1	10.4	5.8
Rated speed n_N	rpm	2000		3000		4000		2000		3000	
Rated power P_N	kW	1.5		2		2.2		2.6		3.5	
Voltage constant k_E ¹⁾	V/1000rpm	145.5	249.6	96.4	164.9	72.4	124.5	152.6	255.0	101.7	168.9
Winding resistance R_{U-V}	Ohm	3.5	10.2	1.5	4.4	0.85	2.6	1.37	4.3	0.6	2
Winding inductance L_{U-V}	mH	9.9	29.3	4.4	12.7	2.5	6.8	6.1	17.9	2.7	8.2
Maximum values											
max. torque M_{max}	Nm	42.0					70,0				
max. current I_{max}	A	28	16	42	25	57	33	46	25	71	40
Mechanical data ²⁾											
Inertia J_L	kgcm ²	12.3					19.5				
Weight	kg	10.2					12.3				

1) Peak value of motor EMC at 1000 rpm specified as phase-to-phase voltage.

2) With resolver; without holding brake



Length L										
Design system	without brake					with brake				
Encoder	Resolver	SIN/COS	EnDat	Hiperface		Resolver	SIN/COS	EnDat	Hiperface	
Size	-	ERN 1387	EQI	SRS/M 50	SRS/M 50/52K	-	ERN 1387	EQI	SRS/M 50	SRS/M 50/52K
E1	231	263	263	238	245	276	308	308	283	290
E2	261	293	293	268	275	306	338	338	313	320
E3	291	323	323	298	305	336	368	368	343	350
E4	336	368	368	343	350	381	413	413	388	395

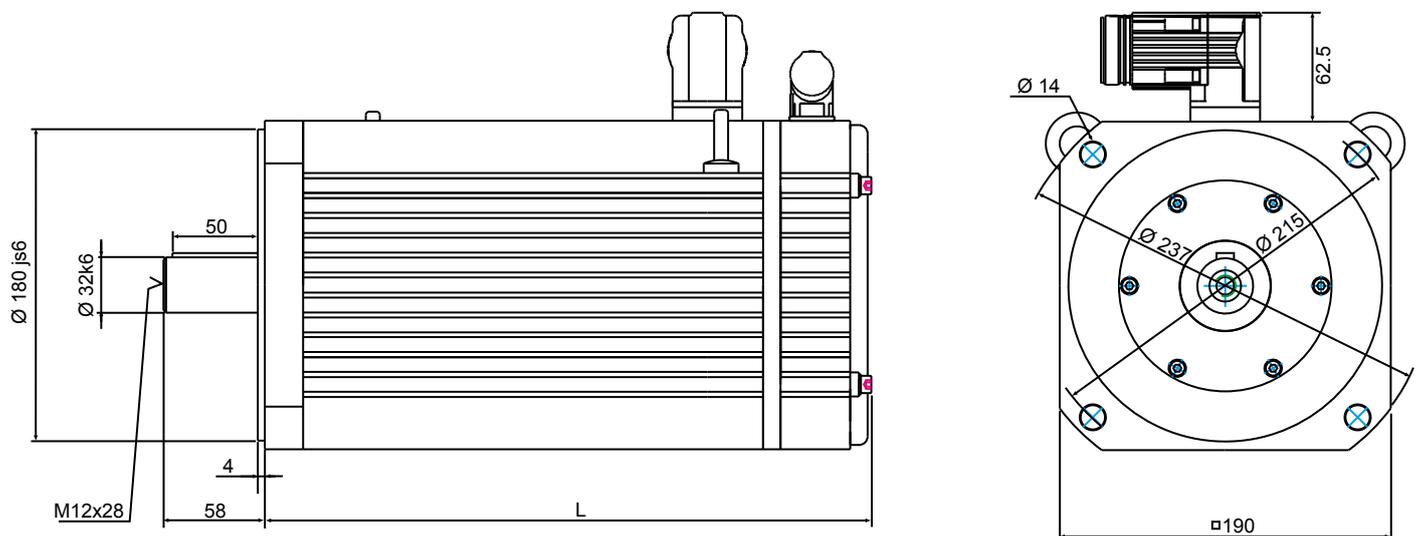
Ex.SM.000-yyyy											
E2		E3						E4			
4200	4400	2200	2400	3200	3400	4200	4400	2200	2400	3200	3400
14		19						27			
17.8	10.0	11.7	6.8	17.6	10.3	21.9	13.5	16.5	9.9	23.2	14.4
230	400	230	400	230	400	230	400	230	400	230	400
7.6		16.5		14.6		8.7		21.4		15.5	
9.7	5.4	10.6	6.1	14.0	8.3	10.4	6.4	13.0	7.8	13.3	8.3
4000		2000		3000		4000		2000		3000	
3.2		3.5		4.6		3.6		4.5		4.9	
79.8	128.1	143.1	247.9	95.5	162.2	76.2	124.0	152.6	259.5	110.5	177.1
0.38	1.14	0.85	2.6	0.38	1.11	0.24	0.64	0.57	1.7	0.29	0.81
1.7	4.7	4.2	9.9	1.9	5.1	1.3	3.0	2.5	7.2	1.3	3.4
70,0		85.0						121.0			
94	53	56	33	84	49	105	65	79	47	111	69
19.5		26.7						36			
12.3		15.5						20.4			

Technical Data

Servo motor		Fx.SM.000-yyy									
Size (x)		F1				F2			F3		
Speed and voltage variant (y)		1400	2400	3400	4400	1400	2400	3400	1400	2400	3400
Stall torque M_{d0}	Nm	25				50			70		
Current at stall torque I_{d0}	A	8.2	11.1	17.0	22.2	17.0	22.3	32.2	23.1	30.8	46.2
Nominal rating											
Rated voltage U_N	V	400				400			400		
Rated torque M_N	Nm	22.5	21.5	20.0	16.0	42.0	38.0	31.0	61.0	52.0	33.0
Rated current I_N	A	7.5	9.7	13.8	14.8	14.5	17.2	20.6	20.9	23.7	22.9
Rated speed n_N	rpm	1500	2000	3000	4000	1500	2000	3000	1500	2000	3000
Rated power P_N	kW	3.5	4.5	6.3	6.7	6.6	7.9	9.7	9.6	10.9	10.4
Voltage constant k_E ¹⁾	V/1000rpm	267.6	198.8	130.0	99.4	254.0	194.2	134.5	261.1	195.7	130.5
Winding resistance R_{U-V}	Ohm	2.36	1.36	0.58	0.34	0.81	0.48	0.23	0.51	0.3	0.13
Winding inductance L_{U-V}	mH	29.7	16.4	7	4.1	12.8	7.5	3.6	6.8	3.8	1.7
Maximum values											
max. torque M_{max}	Nm	88.0				175.0			245.0		
max. current I_{max}	A	29	39	60	78	60	78	113	81	108	162
Mechanical data ²⁾											
Inertia J_L	kgcm ²	84				147			210		
Weight	kg	30.5				44.0			57.5		

¹⁾ Peak value of motor EMC at 1000 rpm specified as phase-to-phase voltage.

²⁾ With resolver; without holding brake



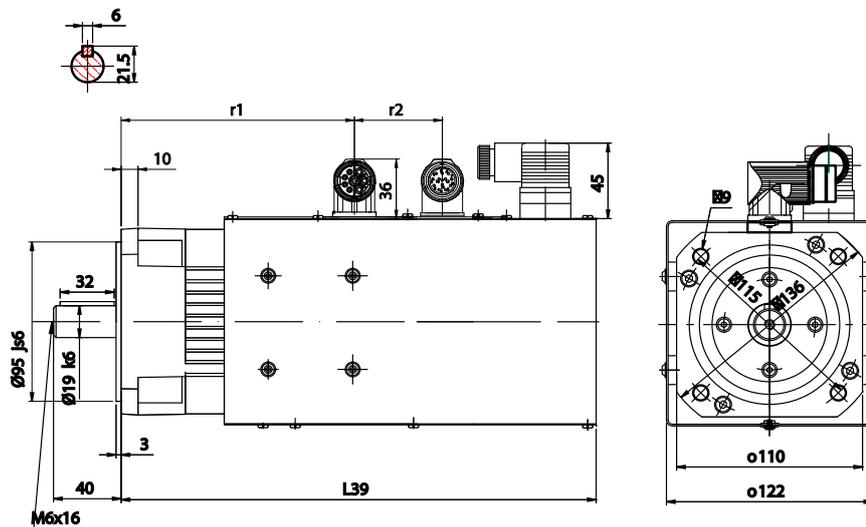
Length L										
Design system	without brake					with brake				
Encoder	Resolver	SIN/COS	EnDat	Hiperface		Resolver	SIN/COS	EnDat	Hiperface	
Size	-	ERN 1387	EQI	SRS/M 50	SRS/M 50/52K	-	ERN 1387	EQI	SRS/M 50	SRS/M 50/52K
F1	348	395	395	355	358	348	395	395	355	358
F2	428	475	475	466	438	428	475	475	435	438
F3	508	555	555	546	518	508	555	555	515	518

7.2 Separate cooling

Servo motor		Dx.SM.000-yyyy										
Size (x)		D1			D2			D3			D4	
Speed and voltage variant (y)		3400	4400	6400	3400	4400	6400	3400	4400	6400	3400	4400
Stall torque M_{d0}	Nm	6.2			10.5			14.5			18.0	
Current at stall torque I_{d0}	A	4.1	5.4	8.1	6.8	9.2	14.2	10.4	14.1	19.7	12.3	16.8
Nominal rating												
Rated voltage U_N	V	400			400			400			400	
Rated torque M_N	Nm	5.5	5.1	4.2	8.7	8.4	7.5	12.2	12	10.5	15.6	15.5
Rated current I_N	A	4.2	5.0	6.7	6.4	8.4	11.7	9.2	12.2	16.0	11.5	14.7
Rated speed n_N	rpm	3000	4000	6000	3000	4000	6000	3000	4000	6000	3000	4000
Rated power P_N	kW	1.7	2.1	2.6	2.7	3.5	4.7	3.8	5.0	6.6	4.9	6.5
Voltage constant k_E ¹⁾	V/1000rpm	82.7	62.0	41.3	84.7	62.9	40.9	84.7	62.4	44.6	85.9	63.1
Winding resistance R_{u-v}	Ohm	6.3	3.9	1.6	3.2	1.7	0.7	1.9	1.04	0.57	1.4	0.76
Winding inductance L_{u-v}	mH	23.8	13.4	6.0	12.8	7.05	3.0	8.3	4.5	2.3	6.7	3.6
Maximum values												
max. torque M_{max}	Nm	18.9			31.5			45.0			54.0	
max. current I_{max}	A	20.4	27.2	40.7	32.5	43.4	67.2	48.8	65.8	92.3	57.7	78.8
Mechanical information²⁾												
Inertia J_L	kgcm ²	4.8			7.4			9.8			12.7	
Weight	kg	7.7			9.6			11.5			13.4	

¹⁾ Peak value of motor EMC at 1000 rpm specified as phase-to-phase voltage.

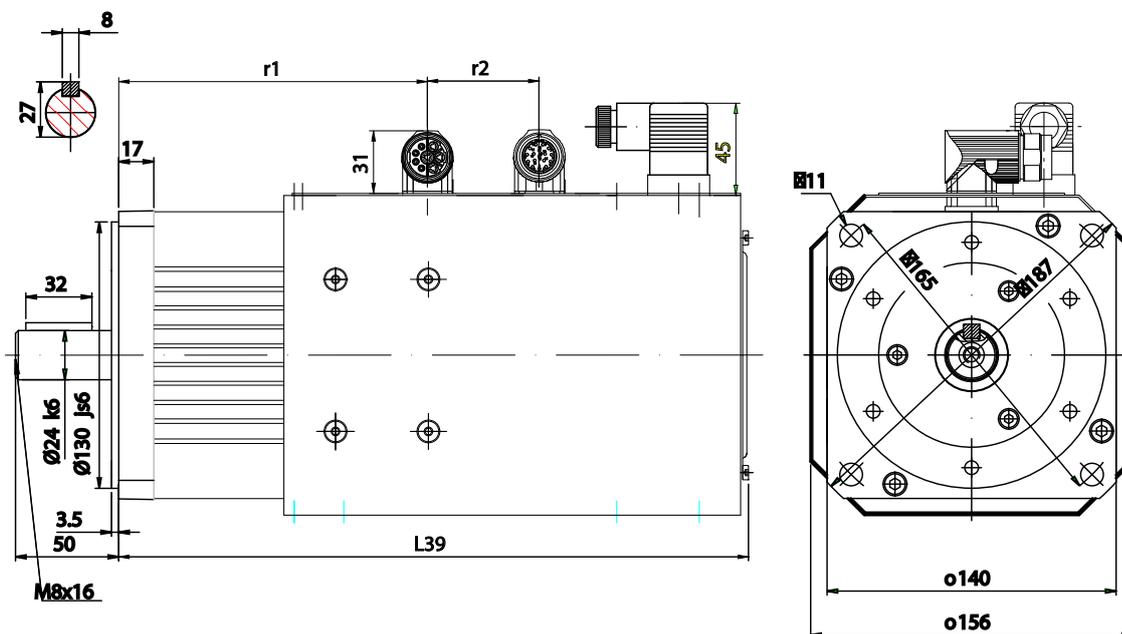
²⁾ With resolver; without holding brake



Length L										
Design system	without brake					with brake				
Encoder	Resolver	SIN/COS	EnDat	Hiperface		Resolver	SIN/COS	EnDat	Hiperface	
Size	-	ERN 1387	EQI	SRS/M 50	SRS/M 50/52K	-	ERN 1387	EQI	SRS/M 50	SRS/M 50/52K
D1	280	321	328	321	321	287	328	328	328	328
D2	310	351	358	351	351	317	358	358	358	358
D3	340	380	388	380	380	347	388	388	388	388
D4	370	410	418	410	410	377	418	418	418	418

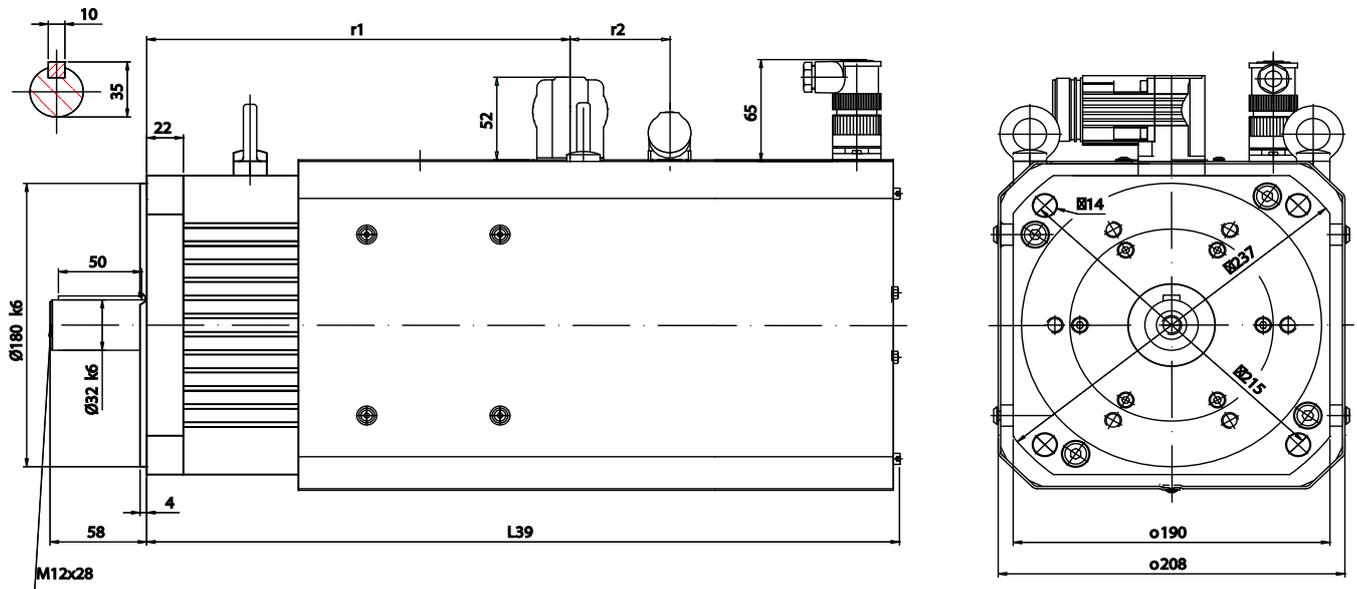
Technical Data

Servo motor		Ex.SM.000-yyyy										
Size (x)		E1			E2			E3			E4	
Speed and voltage variant (y)		2400	3400	4400	2400	3400	4400	2400	3400	4400	2400	3400
Stall torque M_{d0}	Nm	12.9			21.5			30			42	
Current at stall torque I_{d0}	A	7.1	10.1	12.8	10.7	15.5	20.0	14.1	21.6	23.1	21.4	27.8
Nominal rating												
Rated voltage U_N	V	400			400			400			400	
Rated torque M_N	Nm	11.2	10.3	9.3	18.7	17.1	15.5	26	23.8	21.6	33	31.6
Rated current I_N	A	6.5	8.5	9.7	9.8	13.0	15.2	12.9	18.0	17.5	17.7	22.0
Rated speed n_N	rpm	2000	3000	4000	2000	3000	4000	2000	3000	4000	2000	3000
Rated power P_N	kW	2.4	3.2	3.9	3.9	5.4	6.5	5.5	7.5	9	6.9	10
Voltage constant k_E ¹⁾	V/1000rpm	106.3	74.4	58.4	115.1	79.7	62.0	123.9	80.6	74.3	112.9	86.9
Winding resistance R_{U-V}	Ohm	4.5	2.2	1.4	2.4	1.1	0.66	1.6	0.68	0.58	0.84	0.50
Winding inductance L_{U-V}	mH	24.2	11.9	7.3	15.0	7.2	4.3	11.7	4.9	4.2	6.7	4.0
Maximum values												
max. torque M_{max}	Nm	42			70			85			121	
max. current I_{max}	A	23	35	47	35	57	75	46	70	92	67	98
Mechanical information²⁾												
Inertia J_L	kgcm ²	12.3			19.5			26.7			36.0	
Weight	kg	12.2			15			17.8			22	



Length L										
Design system	without brake					with brake				
Encoder	Resolver	SIN/COS	EnDat	Hiperface		Resolver	SIN/COS	EnDat	Hiperface	
Size	-	ERN 1387	EQI	SRS/M 50	SRS/M 50/52K	-	ERN 1387	EQI	SRS/M 50	SRS/M 50/52K
E1	305	347	347	305	347	350	392	392	350	392
E2	335	377	377	335	377	380	422	422	380	422
E3	365	407	407	365	407	410	452	452	410	452
E4	410	452	452	410	452	455	497	497	455	497

Servo motor		Fx.SM.000-yyyy									
Size (x)		F1				F2			F3		
Speed and voltage variant (y)		1400	2400	3400	4400	1400	2400	3400	1400	2400	3400
Stall torque M_{d0}	Nm	39				75			110		
Current at stall torque I_{d0}	A	12.3	16.6	25.4	33.2	25.5	33.5	48.3	34.8	46	69
Nominal rating											
Rated voltage U_N	V	400				400			400		
Rated torque M_N	Nm	35.4	35	31.7	28	64	63	58.2	92.8	90	85
Rated current I_N	A	11.8	15.8	21.9	25.5	22.1	28.5	38.7	31.8	41.1	56
Rated speed n_N	rpm	1500	2000	3000	4000	1500	2000	3000	1500	2000	3000
Rated power P_N	kW	5.6	7.3	10	11.8	10.1	13.2	18.3	14.6	18.9	26.8
Voltage constant k_E ¹⁾	V/1000rpm	189.2	140.6	91.9	70.3	179.6	137.3	95.1	184.6	138.4	92.3
Winding resistance R_{U-V}	Ohm	2.36	1.36	0.58	0.34	0.81	0.48	0.23	0.51	0.3	0.13
Winding inductance L_{U-V}	mH	29.7	16.4	7.0	4.1	12.8	7.5	3.6	6.8	3.8	1.7
Maximum values											
max. torque M_{max}	Nm	88				175			245		
max. current I_{max}	A	41	55	85	110	85	111	160	115	153	229
Mechanical information²⁾											
Inertia J_L	kgcm ²	84				147			210		
Weight	kg	36				51			65		

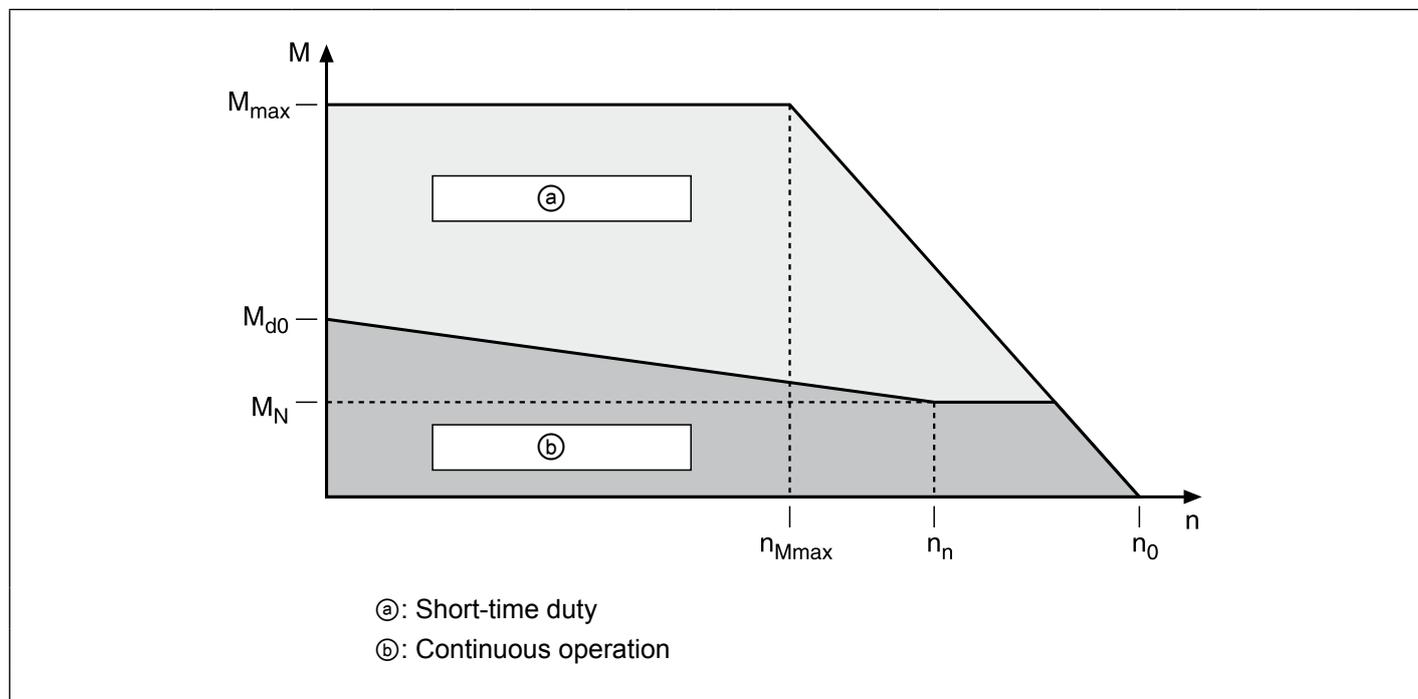


Length L										
Design system	without brake					with brake				
Encoder	Resolver	SIN/COS	EnDat	Hiperface		Resolver	SIN/COS	EnDat	Hiperface	
Size	-	ERN 1387	EQI	SRS/M 50	SRS/M 50/52K	-	ERN 1387	EQI	SRS/M 50	SRS/M 50/52K
F1	452	486	486	452	486	452	486	486	452	486
F2	532	566	566	532	566	532	566	566	532	566
F3	612	646	646	612	646	612	646	646	612	646

Technical Data

7.3 Torque-speed-characteristic

7.3.1 Motors of the 230 V class

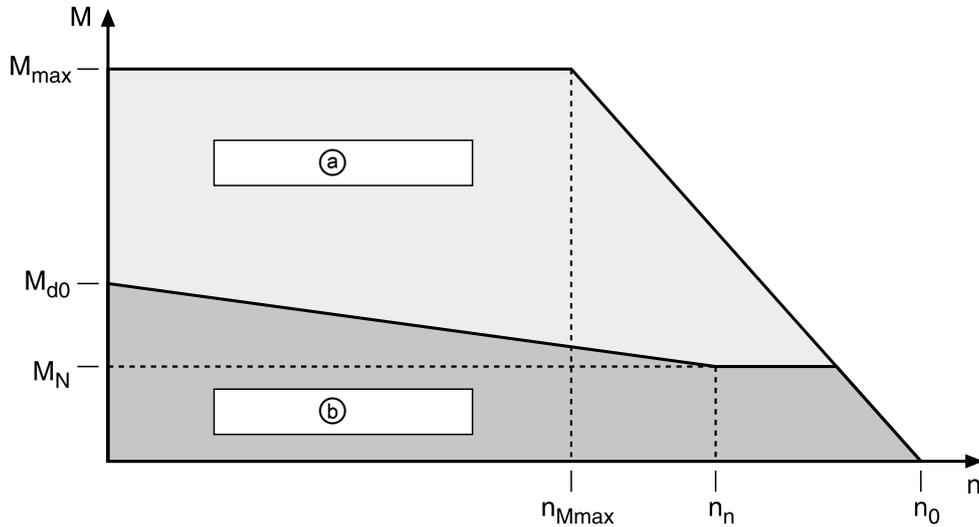


Ⓐ: Short-time duty
 Ⓑ: Continuous operation

Part Number	M_{max}	M_{d0} [Nm]	M_N [Nm]	n_N	n_{Mmax} [rpm]	n_0
A1.SM.000-6200	1.7	0.34	0.32	6000	5950	9500
A2.SM.000-6200	2.5	0.5	0.48	6000	6950	9500
A3.SM.000-6200	3.2	0.65	0.6	6000	7100	9500
A4.SM.000-6200	5	1	0.8	6000	7850	9500
B1.SM.000-4200	3.1	0.65	0.6	4000	5250	9100
B1.SM.000-6200	3.1	0.65	0.5	6000	7250	12300
B2.SM.000-4200	7.2	1.5	1.3	4000	3450	6850
B2.SM.000-6200	7.2	1.5	1	6000	6000	10650
B3.SM.000-4200	11	2.3	2	4000	4700	7200
B3.SM.000-6200	11	2.3	1.5	6000	5950	10200
C1.SM.000-3200	4.3	0.95	0.8	3000	1800	5200
C1.SM.000-4200	4.3	0.95	0.75	4000	2850	6900
C1.SM.000-6200	4.3	0.95	0.7	6000	5350	10350
C2.SM.000-3200	12.2	2.7	2.4	3000	2550	4150
C2.SM.000-4200	12.2	2.7	2.2	4000	3950	5500
C2.SM.000-6200	12.2	2.7	2	6000	6150	8150
C3.SM.000-3200	20.3	4.5	3.9	3000	2600	3850
C3.SM.000-4200	20.3	4.5	3.5	4000	3850	5100
C3.SM.000-6200	20.3	4.5	2.8	6000	5550	7600
C4.SM.000-3200	27	6	5	3000	2600	3950
C4.SM.000-4200	27	6	4.5	4000	3600	5050
C4.SM.000-6200	27	6	3	6000	6300	7650

Part Number	M_{max}	M_{d0} [Nm]	M_N [Nm]	n_N	n_{Mmax} [rpm]	n_0
D1.SM.000-3200	18.9	4.2	3.7	3000	2550	4000
D1.SM.000-4200	18.9	4.2	3.5	4000	3850	5300
D1.SM.000-6200	18.9	4.2	3	6000	5350	7750
D2.SM.000-3200	31.5	7	6.1	3000	2750	4000
D2.SM.000-4200	31.5	7	5.8	4000	4000	5450
D2.SM.000-6200	31.5	7	3.8	6000	6300	7550
D3.SM.000-3200	45	10	8.4	3000	2850	3850
D3.SM.000-4200	45	10	7.6	4000	3950	5300
D3.SM.000-6200	45	10	5	6000	5600	7050
D4.SM.000-3200	54	12	9.9	3000	2850	3650
D4.SM.000-4200	54	12	8.6	4000	3550	4700
E1.SM.000-2200	42	8.5	7	2000	1500	2250
E1.SM.000-3200	42	8.5	6.5	3000	2250	3450
E1.SM.000-4200	42	8.5	5.2	4000	3400	4600
E2.SM.000-2200	70	14	12.2	2000	1450	2150
E2.SM.000-3200	70	14	11	3000	2150	3250
E2.SM.000-4200	70	14	7.6	4000	3300	4150
E3.SM.000-2200	85	19	16.5	2000	1450	2300
E3.SM.000-3200	85	19	14.6	3000	3450	3450
E3.SM.000-4200	85	19	8.7	4000	3400	4350
E4.SM.000-2200	121	27	21.4	2000	1700	2150
E4.SM.000-3200	121	27	15.5	3000	2500	3000

7.3.2 Motors of the 400 V class



Ⓐ: Short-time duty
 Ⓑ: Continuous operation

Part Number	M_{max}	M_{d0} [Nm]	M_N [Nm]	n_N	n_{Mmax} [rpm]	n_0
A1.SM.000-6400	1.7	0.34	0.32	6000	7550	11950
A2.SM.000-6400	2.5	0.5	0.48	6000	6900	10050
A3.SM.000-6400	3.2	0.65	0.6	6000	6600	9350
A4.SM.000-6400	5	1	0.8	6000	6000	8250
B1.SM.000-4400	3.1	0.65	0.6	4000	2800	6850
B1.SM.000-6400	3.1	0.65	0.5	6000	5200	10250
B2.SM.000-4400	7.2	1.5	1.3	4000	1850	5750
B2.SM.000-6400	7.2	1.5	1	6000	4800	8800
B3.SM.000-4400	11	2.3	2	4000	3100	5450
B3.SM.000-6400	11	2.3	1.5	6000	4500	7850
C1.SM.000-3400	4.3	0.95	0.8	3000	1500	4950
C1.SM.000-4400	4.3	0.95	0.75	4000	2850	6550
C1.SM.000-6400	4.3	0.95	0.7	6000	4750	9800
C2.SM.000-3400	12.2	2.7	2.4	3000	2500	4150
C2.SM.000-4400	12.2	2.7	2.2	4000	4000	5550
C2.SM.000-6400	12.2	2.7	2	6000	6150	8350
C3.SM.000-3400	20.3	4.5	3.9	3000	2650	3950
C3.SM.000-4400	20.3	4.5	3.5	4000	3850	5100
C3.SM.000-6400	20.3	4.5	2.8	6000	5450	7600
C4.SM.000-3400	27	6	5	3000	2750	4100
C4.SM.000-4400	27	6	4.5	4000	3950	5350
C4.SM.000-6400	27	6	3	6000	6300	7750
D1.SM.000-3400	18.9	4.2	3.7	3000	2500	3950
D1.SM.000-4400	18.9	4.2	3.5	4000	3850	5300
D1.SM.000-6400	18.9	4.2	3	6000	5600	7950
D2.SM.000-3400	31.5	7	6.1	3000	2650	3900
D2.SM.000-4400	31.5	7	5.8	4000	3650	5200

Part Number	M_{max}	M_{d0} [Nm]	M_N [Nm]	n_N	n_{Mmax} [rpm]	n_0
D2.SM.000-6400	31.5	7	3.8	6000	6550	8050
D3.SM.000-3400	45	10	8.4	3000	2850	3850
D3.SM.000-4400	45	10	7.6	4000	3900	5250
D3.SM.000-6400	45	10	5	6000	5900	7350
D4.SM.000-3400	54	12	9.9	3000	3000	3800
D4.SM.000-4400	54	12	8.6	4000	4150	5200
E1.SM.000-2400	42	8.5	7	2000	1550	2300
E1.SM.000-3400	42	8.5	6.5	3000	2350	3500
E1.SM.000-4400	42	8.5	5.2	4000	3550	4600
E2.SM.000-2400	70	14	12.2	2000	1550	2250
E2.SM.000-3400	70	14	11	3000	2500	3400
E2.SM.000-4400	70	14	7.6	4000	3600	4500
E3.SM.000-2400	85	19	16.5	2000	1800	2300
E3.SM.000-3400	85	19	14.6	3000	2750	3550
E3.SM.000-4400	85	19	8.7	4000	3850	4650
E4.SM.000-2400	121	27	21.4	2000	1700	2200
E4.SM.000-3400	121	27	15.5	3000	2650	3250
F1.SM.000-1400	88	25	22.5	1500	600	1700
F1.SM.000-2400	88	25	21.5	2000	1200	2300
F1.SM.000-3400	88	25	20	3000	1800	3550
F1.SM.000-4400	88	25	16	4000	2850	4650
F2.SM.000-1400	175	50	42	1500	950	1800
F2.SM.000-2400	175	50	38	2000	1300	2400
F2.SM.000-3400	175	50	31	3000	2300	3450
F3.SM.000-1400	245	70	61	1500	1200	1750
F3.SM.000-2400	245	70	52	2000	1700	2350
F3.SM.000-3400	245	70	33	3000	2900	3550

Technical Data

7.4 Options

7.4.1 Holding brake

Motor type		Ax.SM.001-xx00	Bx.SM.001-xx00	Cx.SM.001-xx00
Holding torque	[Nm]	2.0	4.5	9
Inertia	[kgcm ²]	0.067	0.183	0.6
max. speed	[rpm]	10.000	10.000	10.000
Weight	[kg]	0.18	0.30	0.50
Rated voltage	[V]	24 (+6%, -10%)		
Rated current	[A]	0.46	0.50	0.75
Drop-out time t2	[ms]	25	35	40
On delay t11	[ms]	2	2	2
Operate time t1	[ms]	8	7	7
Power	[W]	11	12	18
Type		03.P1.330-0567	05.P1.320-0487	06.P1.320-0087

Motor type		Dx.SM.001-xx00	Ex.SM.001-xx00	Fx.SM.001-xx00
Holding torque	[Nm]	11	36	72
Inertia	[kgcm ²]	2.3	5.9	17.6
max. speed	[rpm]	6.000	10.000	4.000
Weight	[kg]	0.78	1,95	3.8
Rated voltage	[V]	24 (+6%, -10%)		
Rated current	[A]	0.83	1.1	1.67
Drop-out time t2	[ms]	25	90	140
On delay t11	[ms]	3	3	5
Operate time t1	[ms]	25	22	25
Power	[W]	20	26	40
Type		08.P1.320-0357	08.P1.320-0057	09.P1.320-0017

The indicated switching times are reached with adjusted nominal air gap (Xmin). There are average values, whose leakage is dependent on the power supply and coil temperature. The marking of the switching times corresponds to DIN VDE 580.

8. Appendix

8.1 Certification

8.1.2 CE Marking

CE marked servo motors were developed and manufactured to comply with the regulations of the Low-Voltage Directive 2006/95/EC.

The servo motors must not be started until it is determined that the installation complies with the Machine directive (2006/42/EC) as well as the EMC-directive (2004/108/EC)(note EN 60204).

The servo motors meets the requirements of the Low-Voltage directive 2006/95/EC. The harmonized standards EN 60204-1, EN 60034, EN 292-1 and EN 292-2 were used..

An appropriate declaration of conformity is available if necessary via our internetportal.

8.1.3 UL Marking



Acceptance according to UR and cUR is marked at KEB servo motors with the adjacent logo on the type plate as well as by the E-file



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